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An International Review of Forestry and Forest Products

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BOARD CONFERENCE

NEXT January at Geneva, FAO with the Economic Commission for Europe will be convening an international technical conference on insulation board, hardboard and particle board, commodities which have become so important in building and furniture manufacture since the war. The conference will last approximately two weeks, and will aim at providing a more widespread understanding of the technical and economic problems involved in the manufacture and use of fibreboards and particle boards.

The meetings should furnish an excellent opportunity for discussions between equipment suppliers, board manufacturers and users, and between representatives of technical and industrial laboratories drawn from both producing and consuming areas, upon such important subjects as:

1. product description, nomenclature and definitions;
2. world consumption, production and trade;
3. raw materials: wood, non-wood, and additives;
4. processes and equipment;
5. economic aspects of production and marketing;
6. properties, application and uses;
7. research needs to enhance future development.

Papers will be presented on many technical and economic aspects of an industry which between 1946 and 1950 doubled its production, has expanded considerably since then and shows promise of further substantial increases in output during the next few years.

The materials with which the conference will be concerned are phenomena of the past thirty years. First on the scene was insulating board, followed shortly afterwards by hardboard. Particle board, in which chips or wood shavings are pressed or extruded in sheets using synthetic resin as a binder, was a fairly recent development and the industry is still in evolution. Mainly on account of the high cost and amount of binding agent required, most particle boards are more expensive than fibreboards, but they can be produced on a smaller scale than is usually considered economic for fibreboard manufacture and the capital investment required to establish a unit is normally lower.

Further great expansion in production of all these boards is expected to meet increases in demand in the coming decade. Their production opens up the prospect of better scope for utilization of thinnings and of hitherto little used wood species, as well as absorbing considerable quantities of fibrous waste from other industries — such as bagasse, the residual product from sugar-cane grinding operations.

The results of this conference should be to set out clearly the many processes and techniques which are now available for the manufacture of insulation board, hardboard and particle board, as well as to indicate the likely future trend of development in the industries, providing guidance to actual or potential suppliers and consumers alike.

Cover Photograph: *Although cross-country freighters are hardly suited for everyday travel on public thoroughfares, this photo illustrates their almost uncanny ability to maneuver sharp corners. Each "trailer" furnishes its own locomotion through powerful electric motors tucked into each wheel thus giving this particular train a 32-wheel drive. Rectangular shapes on the lead car are, from left: operator's cab with seats for seven people, 3,500-gallon fuel tank, and two engines with generators to furnish power to the electrically-driven wheels. Manufacturer, is R. G. Le Tourneau, Inc., of Longview Texas, where this photo was taken.*

FIGURE 1. *Java: A low-cost housing project at Djakarta. Timber frames, weather-board cladding, solid floors and cement-tile roofs.*

FIGURE 2. *Flores: Typical "campong." The houses have timber frames, steeply pitched thatch roofs and no walls.*

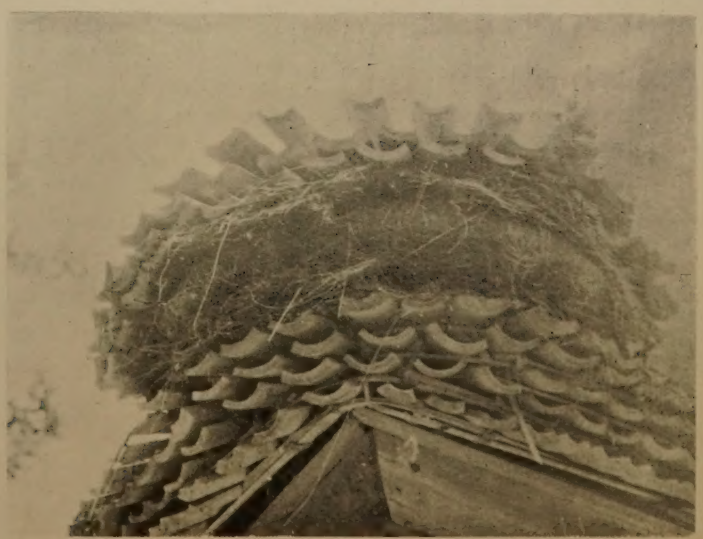

FIGURE 3. *Bamboo Roof Shingles: Detail of gable finnial finished with "injuk," the hair of the aren palm.*

Housing Development in Indonesia

by The Inter-Secretariat Working Party on Housing and Building Materials in Asia and the Far East

In Asia and the Far East, climate is the greatest single factor influencing housing design, which varies very widely in character. Consider, for instance, the difference in climate between the hot-arid areas of West Pakistan and Central India, the hot-humid areas embracing parts of the Indian sub-continent and the major part of Southeast Asia, and the cool or cold areas of the hill regions of the Asian mainland, of Japan and of Korea. The people everywhere have evolved their traditional houses and their methods of utilizing available materials to suit local climatic conditions, which naturally exert a deciding influence on the abundance or otherwise of organic building materials such as timber, bamboos and thatches. Only in the larger cities and towns are buildings to be found which may not be suited to the climate. There are a number of reasons for this but notably the fact that in some countries unsuitable design influences have been superimposed in the past and retained up to the present day, which originate in foreign regions of completely different climatic status.

Building construction in the islands of Indonesia covers a wide range of types, from the solid permanent structures introduced by the Dutch administration to traditional rural buildings, determined by the climate, and which have not varied much in character over the centuries.

The Republic of Indonesia lies across the equator. Although the islands are equatorial, temperatures are moderated by the sea and never become excessive. Hot nights and high humidity are however characteristics of the lowlands. Temperature is largely a matter of elevation rather than season, for the duration of sunlight on the longest and shortest days differs by only 48 minutes. In Djakarta, at sea level, the warmest and coolest monthly averages are within one degree, with the yearly average of 79° F. (29.1° C.). In contrast, Bandung at 2,395 ft. (730 m.) has a yearly average of 71° F. (22° C.), and Gede at 9,914 ft. (3,021 m.) has 48° F. (8.9° C.). Frost occurs only on high sheltered plateaus.

Note: The Inter-Secretariat Working Party is made up of representatives of the United Nations Economic Commission for Asia and the Far East, the United Nations Department for Economic and Social Affairs, the International Labour Organisation, Unesco, the World Health Organization, and FAO. Its last meeting at Bandung, Indonesia, 20-29 June 1955 was also attended by experts from the two regional housing research centers which are in process of establishment in India and Indonesia, to serve respectively the hot-arid and the hot-humid zones of the region.

For the future, the development of the building materials and construction industries will be closely tied to the economic situation of the country as a whole. A detailed examination has been made of the present situation and development prospects for cement and cement products, mortars, building blocks, steel, bricks and clay roofing, tiles, builders' hardware, coconut fibre and ramie waste, sand and gravel. But all these materials are mainly requirements for urban housing, and it is with the requirements for rural housing that FAO is likely to be most concerned.

As in most other countries of Southeast Asia, the dominating indigenous material in Indonesia is bamboo.[1] Ironwood roofing shingles have been widely used in the past, although this material is now becoming rarer. Palm leaf and grass thatching is used throughout the whole archipelago. Perhaps the best traditional houses, and certainly the quaintest, are those of North and West Sumatra, with their high-pitched roofs whose gables are upswept to a high peak, forming a saddle-backed ridge.

Bamboo

There are 15 principal bamboo varieties throughout Indonesia, of which six are in abundant supply and commonly used. These are:

	Height (meters)	*Diameter* (centimeters)
Bambusa bambos (" Bambu Oriduri ")	25	15
Bambusa vulgaris (" Bambu Grading ")	20	10
Dendrocalamus asper (" Bambu Petung ")	30	20
Bambusa spinosa (" Bambu Greng ")	20	12
Gigantochloa apus (" Bambu Apus ")	20	15
Gigantochloa venticallatta (" Bambu Andong ")	26	15

Preservation

The normal useful life of exposed bamboo components (untreated) in a building varies from three to five years in Indonesia according to the species, climatic

[1] Reference is invited to:

F. A. McClure, *Bamboo as a Building Material*, U. S. Department of Agriculture, Foreign Agriculture Service (Washington, D.C., May 1953);

" Industrial Raw Materials of Plant Origin. V. A Survey of the Bamboos, " *Engineering Experiment Station of the Georgia Institute of Technology Bulletin, XV*, No. 18, (Atalanta, Georgia 1953).

FIGURE 4. *Moluccas: A sago palm house. Timber frame, "gaba gaba" panels and roof of thatched fronds.*

factors and the structural design. Some investigations have been made into chemical preservation methods, but these methods have not as yet been applied on a large scale, owing to the expense involved. The standard method of preservation widely used in Indonesia and also in Burma and Thailand is to immerse the bamboo components, which consist of strips or plaited mats, in water for not less than one month. It is claimed that this simple process greatly reduces the susceptibility of the bamboo to deterioration due to insects and micro-organisms, which attack the comparatively soft internal fibres. While the scientific facts concerning this treatment have apparently not been published, it has been stated by competent construction authorities in Indonesia and elsewhere that bamboos subjected to it may last for 10 to 15 years.

Construction

For rural house construction, "petung" is generally used for posts and frames (diameter not less than 9 centimeters) with roof framing of "andong" and tile laths of "petung" or "andong" (7 centimeters diameter for roof framing, and not less than 4 centimeters for laths and bracing). "Bambu apus" is considered suitable in small members of 4 centimeters diameter or thereabouts. Rural structures are usually tied together with lashings made from rattan, "aren," or bamboo rope. If done carefully, such connections will outlast the frames. In the best construction, bamboos are cut at node points, or if this is not possible, the open ends are plugged, to prevent the ingress of vermin. If in contact with the ground, bamboo members are customarily covered with "injuk" (the hair of the "aren" palm) and asphalted, to preserve them. It is, however, more usual to construct a raised plinth of brick or stones on which the bamboo frame is then built.

A common method of constructing wall and floor panels is known as "plupuh." These panels consist of halved and flattened bamboos placed vertically on and lashed or pinned to horizontal round members which are, in turn, fitted to mortices made in the vertical bamboo framing poles of the structure, or secured to form floor or ceiling. "Plupuh" is rather crude and is not weathertight in itself; in consequence, the floors of these panels are generally covered with closely plaited matting. External "plupuh" walls are similarly treated or finshed with plaster externally or on both sides.

"Gedek" is plaited from flattened bamboos 2 to 3 centimeters in width. A loose weave is adopted if plastering is to be applied. The closer woven "gedek" is commonly used for walls and ceilings, walls being either whitewashed with chalk, asphalted and sprinkled with sand, or plastered. Ceiling "gedek" is covered with paper (2-ply) and given a wash of chalk or painted. "Gedek" is also commonly used as panelling for doors and windows.

"Kepang" is a finer-woven version of "gedek" and is generally applied without paint or paper finish. For external walls the hard bamboo skin is placed on the outside, and for ceilings this skin faces downwards.

Bamboo roofs

The simplest form of roof is constructed with halved bamboos running full length from ridge to eaves. Large diameter culms are split into two halves, the first layer being tied or nailed to purlins with the concave face upwards. The second layer is then placed over the first with convex face upwards, the whole interlocking to form a pattern rather similar in appearance to "Roman pattern" tiles. This roof is simple and can be made completely weather-tight. It is not, however, suitable in plague areas, due to the possibility of its harboring rats.

A sound roof can be constructed of bamboo shingles. These are cut from well-grown but still green culms of maximum diameter, the shingles being formed of split segments of 3-4 centimeters width. The length is determined by the distance between the nodes. A "hanging-split" is formed on the inside of the shingle at the node end and the tiles are fixed to split-bamboo battens by hooking this hanging-split over them. Shingles are cured by air-drying in the shade, to avoid the occurrence of splitting during the process. Tile battens are spaced on the rafters at approximately 15 centimeters apart and some 200 shingles are required to cover one square meter of roof. The minimum pitch on bamboo roofs, both halved bamboos and bamboo shingles, should be 30 degrees.

Plague prevention

In many areas of Indonesia plague is endemic and sometimes becomes epidemic. As this disease is carried and transmitted by rats, any construction is unsafe which harbors these rodents and from which they cannot be eliminated.

Bamboo construction is, therefore, totally banned in plague areas and in others it is permitted only if the construction details are such that the buildings will not harbor rats. This means blocking all open ends, closing ridge cappings, box gutters and cavities and using halved or segmental bamboo sections in preference to full rounds. Bamboo construction details of the type considered suitable for plague prevention have been prepared and are available free to home builders from the Department of People's Housing.

Research

Many authorities on the subject consider that for the greater part of Indonesia, and especially for Java with its highest density of population, bamboo is by far the most important building material. It is further felt that research should concentrate on methods of improving its properties and uses, rather than on seeking substitutes for this fine and versatile material.

A committee was set up before the second world war to make a study of bamboo, but was not able to make very much progress regarding cultivation, harvesting, conservation and constructional methods. Some tests are now being carried out on the mechanical properties of Indonesian bamboos when used as reinforcing material in concrete and on methods of impregnation for preservation.

Experiments were first made with split bamboo having toothed ends. The tensile strength was influenced favorably by increasing the length of the toothing. It was found that the shape of the teeth was also important. A second method consisted in splitting and looping the ends to form anchorages. These experiments have not yet been completed. Also being investigated as a possible means of achieving a pre-stressing effect is the use of bamboo strips which have been saturated in water.

Recent experiments with chemical impregnation have shown promise and results to date may be summarized as follows:

1. Pressure methods are successful only if the bamboos are pierced at the septums or if holes are drilled in the inter-nodes.
2. In freshly cut bamboos (with leaves) conserving liquids are easily sucked up to a considerable height and in sufficient quantities.
3. Impregnation by immersion (preferably using Wolman salt) gives good results after 8 or 12 days.

SAGO PALM

The sago palm (*Metroxylon sagu* – Indonesian "sagu") is plentiful in Sunda (local designation "kiraj"), Java ("amblung," "kersula," "resula," "rembulung") and Madura ("bulung"). Its trunk and leaves are very largely utilized for building purposes, particularly in the Moluccas, and apart from this its sago is a major item of diet, one trunk yielding sufficient for several months' food for a family. The palms grow in swamps and reach a height of 10 to 15 meters and a diameter of 60 centimeters in 10 or 12 years. The leaves attain a length of 1.0 to 1.20 meters and have a longer life as roof-thatch than most other palm leaves. The skin or bark is used for making rope or for plaiting matting or decorative wall covering (Indonesian: "tikar Bogor," mats from Bogor. The stalk ("gaba gaba"), after being trimmed to a length of some 3 to 5 meters and split, is placed vertically to dry out, during which process its weight is reduced from 0.8 to 0.5 kilograms per square meter and a specific gravity of only 0.25 is finally reached. When growing, the color of the stalk is light green; after drying it becomes a dark brown. The "gaba gaba" has the advantage of lightness and can thus readily be transported by road or by drifting down streams or along the seashore. Matured dry "gaba gaba" has a fairly good resistance to insect attack and if satisfactorily installed will last for 12 to 15 years in external walls.

For the construction of walls and ceilings, the halved stalks are trimmed to length, only the center portion of the trunks being used. The ends are then shaped to a 45 degree arris with a simple tool designed for the purpose. Two men can prepare between 20 and 25 pieces in an hour. The prepared "gaba gaba" is

FIGURE 5. *"Plupuh": A much-used type of bamboo panelling.*

FIGURE 6. *West Sumatra: A building roofed with "injuk." Some such roofs are known to have been in use for as long as fifty years without major repairs.*

then placed vertically on the wall-framing, the arris ends being fitted into grooved girts top and bottom and the "gaba gaba" butted together vertically as snugly as possible. The whole panel is then fastened with bamboo nails and rope lashings. "Gaba gaba" construction cannot be whitewashed successfully but may be painted if funds permit. One hundred trimmed sticks are required for a wall or ceiling of 6 square meters.

RAMMED EARTH WALLS

The Laboratory of Soil Mechanics and Roads at Bandung has been experimenting with rammed and stabilized wall construction since August 1952. The results to date do not appear very conclusive. The work is of interest in relation to experiments elsewhere, in that it incorporates pozzolano and hydrated lime in the soil mixes adopted.

A small house and numerous walls have been constructed with wall thickness varying from 4 to 8 inches (10 to 20 cm.) only. Some are reinforced with bamboo strips. The main difficulty encountered has been shrinkage and cracks in finished walls, no doubt due to an unsatisfactory soil mix containing too much clay and silt. The use of bamboo reinforcement is claimed as successful, although elsewhere it has not usually been found advisable to use reinforcement of any kind in this work.

The Australian Commonwealth Experimental Building Station recommends a minimum wall thickness of 12 inches (30.5 cm.) externally, and 9 inches (22.9 cm.) for internal partitions, and has developed an ingenious movable timber form-work with inbuilt wooden rollers, which greatly reduces the time taken up in placing and replacing shuttering. The Laboratory at Bandung may well find it profitable to do further research along the lines already investigated in Australia and demonstrated on pilot schemes in Israel, India and Ceylon recently, but continuing with trass as a component of the soil mix. Its further development with lime as a stabilizing agent in rammed earth work will no doubt bring interesting results and a desirable reduction in cost, particularly for self-help projects in urban and suburban localities.

CONCLUSION

Indonesia's building development plans are considerably hampered at present by a shortage of foreign exchange. A major improvement in domestic cement output is most essential as a first step towards urban housing development with a target of not less than one million tons per year. The building of plants throughout the archipelago to process coconut fibres, ramie waste and other organic materials into building boards, seems to be a desirable project.

The traditional methods of treatment and processing of organic building materials for housing, especially bamboo, require careful evaluation as certain local techniques — with slight improvements — may become generally applicable for low-cost housing. Methods for the increase of durability, retention of shape and reduction of seasoning period and of the cost should have high priority.

Efficient use of organic building materials and methods of construction are inter-related; they should be thoroughly adapted to each other and should be considered simultaneously. The gap between existing international knowledge and the practical application of experience by local builders is extremely wide in the case of organic building materials. Dissemination of such experience in practical and adequate form over all parts of Southeast Asia is imperative. The gap between existing international knowledge and its practical application can best be bridged by translating knowledge in the field through pilot projects. This approach should bring out with emphasis the advantages of implementing new practices.

Wood Saccharification

A Summary Statement [1]

by J. A. Hall, Director, J. F. Saeman, Chemist, and J. F. Harris, Chemical Engineer,
Forest Products Laboratory, Forest Service, United States Department of Agriculture

Few industrial chemical processes have had histories to match that of the saccharification of wood. From the earliest days of organic chemistry, scientists have been intrigued by the fact that most cellulosic wastes are two-thirds carbohydrate, which by appropriate treatment can be converted to sugars useful as food or for the preparation of chemicals.

Despite early hopes and a large amount of research and development work, wood saccharification has not lived up to expectations. It has had a disappointing history indeed, with perhaps a score of expensive failures, but today hope seems to burn as brightly as ever—the mistakes of the past being written off as having little bearing on the future. Scientists and industrialists recognize in cellulosic wastes a vast potential source of food and chemicals. Moyer (*39*) [2] in a recent paper on the future of cellulose included the following predictions:

> "The hydrolysis of cellulose to glucose and simple oligosaccharides will become a dominant economic factor... Cellulosic byproducts will find increased utilization as raw materials for the production of simple aliphatic chemicals through chemical engineering and biological processes... Looking far into the future we can see that cellulose, the most abundant of all photosynthetic products, will become one of man's most useful raw materials. The supply is replenished by growth while materials stored from past ages are continuously depleted."

It seems reasonable to assume that, with our present technological tools and with sufficient research effort, processes can be made available for efficiently utilizing cellulosic wastes. The importance of the development of such processes can be judged by viewing the possible consequences of such accomplishment.

Probably the most important and far-reaching result of the development of an economic saccharification process would be the effect it would have on forest management and utilization. It would be possible to clear unproductive forest land which could be replanted to yield trees of value for lumber, pulp, and cellulosic residues for chemical conversion. This aspect alone has far-reaching consequences and justifies the expenditure of much research effort.

Another effect which cannot be subjected to a direct economic evaluation is the political aspect of self sufficiency and the balance of foreign exchange. Any country with an abundant source of cellulosic waste material could process the material to fuel or food in the event of war without drawing on its productive farm lands. However, a saccharification process intended to produce sugar for the production of power alcohol offers little justification for research. Cederquist (*52*), in a paper given at Lucknow, points out that if fuel is needed it is better by several fold to use the cellulosic material as fuel rather than attempt conversion to alcohol. The ultimate criterion by which to judge the importance of a saccharification process is in the light of current economics. The picture varies greatly depending on the locale under consideration. However, some generalizations can be drawn.

Considering the use of sugar as a food, it is well to note that pure crystalline sucrose of almost 100 percent purity may be bought currently on the world market (f.o.b. Cuba) for slightly over 3 cents per pound, and sugar in the form of blackstrap molasses for animal feeds can be bought at roughly half this price (*22*). The deciding factor here is the transportation costs to the point of consumption. In many localities this brings the cost to where sugar from available cellulosic wastes might be made at competitive prices. Other facets of this aspect include the long-range outlook where it might appear that much larger supplies of food are necessary to feed the world's population. Hass and Lamborn (*22*) claim that the world's sugar production from sugar cane could be easily doubled and thus point out that the problem of sugar production is not pressing. Countries faced with food shortages would also have to compare the benefits derived from money spent on cellulose conversion to those derived from money spent on fertilizing available lands.

Cellulosic residues considered as a chemical raw material are a source of hexose and pentose sugars. The major portion, the hexoses, are equivalent to sugar from common sources. The pentoses, on the other hand, are unique, as they may be processed to furfural, a chemical which has not been produced from other sources. The pentosans in corncobs and bagasse

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Note. – The Forest Products Laboratory of the Forest Service is maintained at Madison, Wisconsin, in co-operation with the University of Wisconsin.

[1] Prepared at the request of FAO in connection with the work of the Technical Panel on Wood Chemistry.

[2] Numbers in parentheses refer to the literature cited at the end of this report.

are now the main source of furfural. The pentosan content of wood, however, is too low for an economic venture supported by this single product.

The brief considerations above lead to the conclusion that while there are indirect benefits to be gained by the development of a technically feasible saccharification process the important yardstick is economics. To be of value the process must be capable of producing sugar at a price competitive with cane sugar or cane molasses in the locality in which it operates.

Purpose and scope

This statement was prepared at the request of the Food and Agriculture Organization of the United Nations to serve as the basis for a report for distribution to Member Governments. Its purpose is to describe developments in the field of wood saccharification, to discuss the possibilities and the economic and technical difficulties of the process, and to outline courses of investigation and research which appear to offer most promise.

It is beyond the scope of this paper to provide a full coverage of the science and technology of wood saccharification, but enough of the technical aspects will be presented to characterize the methods under discussion.

Wood saccharification is but one aspect of a larger problem—the chemical utilization of cellulosic residues. Sugar is but one of many products obtainable from cellulosic residues, and wood is but one of a variety of potential starting materials. It so happens that most of the available literature on the chemical utilization of cellulosic wastes deals with wood. Wherever possible in this report, coverage is extended to products in which sugar appears only as an intermediate.

Sources of information

There is much information in the literature on the production of sugar and alcohol from cellulosic materials, but comparatively little on the industrial and economic aspects of the problem. The books by Hägglund (*20*), Wise and Jahn (*56*) have sections devoted to the subject that include large bibliographies. Early industrial work has been described by Foth (*10*) and Demuth (*6*). The development of the Scholler process is described in the German literature (*13*, *14*, *35*, *46*, *49*). The history of early wood saccharification processes in the United States has been described by Sherrard and Kressman (*51*). A series of papers included in a symposium on sugar from wood and agricultural waste has been printed in Industrial and Engineering Chemistry (*23*). Saeman, Locke, and Dickerman, following World War II, have reported on the production of wood sugar in Germany and its conversion to yeast and alcohol (*45*). Harris (*21*) in 1949 reviewed wood saccharification in the annual *Advances in Carbohydrate Chemistry*. The well-constructed and operated wood-sugar alcohol plant in Ems, Switzerland, has been described (*42*, *54*).

Gilbert and his co-workers of the Tennessee Valley Authority have published details of their pilot-plant study of wood hydrolysis using a percolation process (*15*). A general discussion of the subject of wood hydrolysis and a description of the American plant at Springfield, Oregon, has been published (*44*).

Wenzel (*55*) in 1954 published a thorough review of the chemistry and technology of the acid hydrolysis of wood. These various sources present a full background on wood hydrolysis.

The production and use of power alcohol was the subject of a United Nations-sponsored seminar held at Lucknow, India, in 1952 (*52*). This seminar included the subject of wood-sugar production. Wood saccharification was the subject of the sixth meeting of the FAO Technical Panel on Wood Chemistry at Stockholm in 1953 (*8*). Particular attention is paid in this report to the information presented at these meetings.

The Constituents of Wood

The amount and nature of the sugars obtainable from wood, and the processes required to effect the necessary hydrolysis, are determined by the polysaccharides of the wood.

The main polysaccharide in all woody-plant materials is cellulose. This cellulose is chemically and physically similar to cotton in that it is fibrous, has a high resistance to alkali, and is hydrolyzed only with much difficulty to yield glucose.

Hemicelluloses are present in wood and other cellulosic materials to an extent of roughly one-third of the total carbohydrate. The hemicellulose is amorphous and because of its lack of crystalline organization, it hydrolyzes much more easily than does cellulose. If the total carbohydrate of wood were hydrolyzed as easily as is hemicellulose, there would be no question about the immediate widespread industrial usefulness of wood saccharification.

The component sugars of the total hydrolyzate of 20 different species of woods have been determined by Gustafsson and co-workers (*19*). According to these workers, all the wood species investigated contain glucosan, galactan, mannan, araban, and xylan. The amount of galactan based on the total sugar produced by the hydrolysis of softwoods varies from 6.0 to 17.5 percent, and that of mannan between 7.5 and 16.0 percent. The corresponding values for hardwood are 1.0 to 4.0 percent and 0.5 to 4.0 percent, respectively. The xylan content of softwood varies between 9.0 and 13.0 percent, and that of hardwood, between 19.5 and 39.0 percent. The araban content is low throughout and exceeds 3 percent only for three of the softwood species. The carbohydrate composition of a given species is not strictly constant, but the variations that exist are not sufficient to obscure the characteristic differences between hardwoods and softwoods.

Lignin is the main noncarbohydrate constituent of wood and other plants. It is essentially a high poly-

meric aromatic material, and most of it remains through hydrolysis procedures as an insoluble residue amounting to 20 to 30 percent of the wood. The chemistry of lignin has recently been comprehensively reviewed by Brauns (*5*). While lignin has found little use in the past, it might well prove to be the key to some future successful process for the integrated utilization of cellulosic residues.

Saccharification Processes

The conversion of cellulosic materials to sugar appears at first glance to be a simple hydrolytic cleavage of glycosidic bonds. As such, one should expect the reaction to be simple, and the capital costs of a factory to be low. In reality, cellulose is unique among the known polysaccharides in its extreme resistance to hydrolysis. The glycosidic bonds themselves are easily broken, but the crystalline organization of the cellulose results in a low accessibility to dilute acid commonly used as a catalyst. As a consequence, the conditions of temperature and acid concentration required to accomplish the reaction in a reasonable time cause serious decomposition of the resulting sugars. Faced with these facts, only a few basic alternatives have presented themselves for practical hydrolysis.

1. A simple dilute-acid hydrolysis can be carried out without separation of product as it is formed.
2. A percolation process can be employed in which yields are raised by the expedient of continuously removing the product as it is formed.
3. A concentrated acid process can be used in which the crystalline organization of the cellulose is destroyed, the carbohydrate solubilized, and finally completely hydrolyzed with dilute acid.

All commercial processes fall into these three categories.

The simple dilute-acid hydrolysis of wood

The single-stage batch process of wood hydrolysis was the first commercial method for making sugars from wood. The process has the advantage of great simplicity, and, with improvement, it might still be the method of choice in certain situations.

Plants using this simple process were operated at Georgetown, N. C., and Fullerton, Louisiana, during the period just preceding to just after World War I. According to Sherrard and Kressman (*51*) these plants produced 5,000 to 7,000 gallons of alcohol per day. The Georgetown plant was described by Foth (*10*) and Demuth (*6*). Concurrent experimental work was described by Kressman (*32*). In 1921 Sherrard presented an engineering study of the process (*50*).

At the Georgetown plant, the wood was processed on a 1-hour cycle in four spherical digesters, each holding 4,700 pounds of dry wood. The sugar was extracted in a battery of eight 150-cubic-foot cells arranged for countercurrent extraction. About 96 percent of the sugar was extracted to give a solution containing about 12 percent total solids, nearly 9 percent reducing sugar, and roughly 6 percent fermentable sugar.

Giertz (*8*) described a process used in Sweden during World War II for the continuous hydrolysis of waste-wood. The wood chips were impregnated in a tower with sulphur dioxide gas. The bottom of the tower was connected to the feeder mechanism of an Asplund defibrator. The chips were heated in the preheater at 180° C. for 2 to 3 minutes, ground in the defibrator, and the pulp pressed out continuously through an expansion valve. Seven such units operated in parallel. The pulp was washed in centrifuges and the solubles were reacidified and hydrolyzed further. The sugar solution at a concentration of 8 percent was fermented with the spent sulphite liquor of the plant. Plans to saccharify the cellulose in the residue were worked out, but never realized. The residual lignocellulose was used as a fuel. Attempts to use it as a filler for bakelite plastics were unsuccessful.

The operation of the plant was dependent on high alcohol prices granted by the government. Operations were discontinued after the war, and the plant was dismantled in 1946.

A wood-hydrolysis process has been described in which a slurry consisting of 8 to 10 parts of dilute acid to one of sawdust is pumped through a heat exchanger (*24, 25, 40, 41*). This has not been used commercially. The purpose of the process was the production of a lignocellulose plastic. As a means of producing sugar, the method has the disadvantage of giving dilute solutions because of the high liquid-to-solid ratio.

The simple batch hydrolysis of cellulose has attractive features, but there has been a serious limitation on yield. More work on the kinetics of the reaction has provided hope that yields can be improved.

Following the commercialization of batchwise hydrolysis during World War I, Meunier (*37, 38*) and Despar-met (*7*) published their research on the subject, indicating the desirability of using successive hydrolysis stages.

In 1945, Plow and his co-workers described experiments in which several stages of hydrolysis were used (*43*).

At a seminar on the production and use of power alcohol in Asia and the Far East, Cederquist (*52*) described a process developed in Sweden during the war. Pilot-plant studies were carried out in full-scale batch reactors, but the process was not put into production.

The following summary of the process is taken from the report presented by Cederquist:

> " A careful investigation of all the known processes indicates that hydrolyzation with dilute acids, properly carried out, involves considerably

lower costs than hydrolyzation with concentrated acids, but there is still room for inventions to improve the process. The author and his co-operators carefully reviewed the hydrolyzation problem during the war, and our investigations resulted in a proposal to carry out the process on acid-impregnated, subdivided wood in two stages in an atmosphere of steam. Approximately 50 percent of the wood (dry) is converted to sugar and the sugar solutions obtained have a concentration of 10-12 percent.

" The conclusions of our investigation may be summed up as follows:

1. A fairly good yield of sugar (48-50 percent);
2. A high concentration of sugar (10-12 percent);
3. All pentoses enriched in the first stage solution which facilitates the utilization *of the pentoses*: the sugar formed in the second stage consists entirely of glucose;
4. The total consumption of sulphuric acid is low, and amounts to 20-25 kilograms per ton of wood;
5. The consumption of steam without heat recovery amounts to 1.3 tons per ton of wood;
6. The digesters for carrying out the hydrolyzation are of small size, because of the short time of hydrolyzation. Fifty tons of wood a day may be converted to sugar by using two digesters of 3 cubic meters each and two of 2 cubic meters each.

" The hydrolyzation is carried out under the following conditions:

1. The wood is used in the form of thin shavings, chips or sawdust.
2. The wood is impregnated with weak acid and freed from excess of liquor prior to hydrolyzation.
3. The hydrolyzation is carried out in an atmosphere of steam.
4. *Stage I*
   (*a*) Impregnation with a liquid containing 0.5 percent sulphuric acid:
   Temperature: 190° C.
   Steam pressure: 12 kilograms/square centimeter.
   Time of hydrolyzation: 3 minutes.
   (*b*) Washing out the sugar on a continuous counter current bed filter.
5. *Stage II*
   (*a*) The residue from Stage I is impregnated with a solution containing 0.75 percent sulphuric acid:
   Temperature: 215° C.
   Steam pressure: 20 kilograms/square centimeter.
   Time of hydrolyzation: 3 minutes.
   (*b*) Washing out the sugar on a continuous counter current bed filter. "

Percolation processes

In saccharification by percolation processes, wood is put into an acid-resistant pressure vessel and hydrolyzed by dilute acid injected into the top of the vessel and withdrawn through a filter in the bottom. In this way, sugar production and extraction go on simultaneously, and the sugar is separated and cooled as soon as possible to prevent decomposition.

The industrial development of the Scholler process using the percolation technique, has been described by Schaal (*46*), Fritzweiler and Rockstroh (*14*), Lüers (*35*), Scholler (*48*, *49*), and Fritzweiler and Karsch (*13*). These sources do not give detailed information on the process, but in 1945 operating details of the Tornesch and Holzminden plants were obtained (*45*, *17*).

At the present time there are three Scholler plants in Germany, the Tornesch and Holzminden plants in the western zone, and the Dessau plant in east Germany. There is also one in Switzerland and another in Korea.

Typically, a Scholler plant has six or eight 50-cubic-meter digesters constructed of steel and lined with acid-resistant tile. The diameter of these digesters is 2.4 meters, and the over-all height about 13 meters. The top of a digester, or percolator, has steam and vent lines and a line for the introduction of hot dilute acid. The bottom is equipped with a filter cone and a quick-opening discharge valve for removing the lignin residue. The digester is loaded with 9 to 10 metric tons of sawdust and chips to a density of 180 to 200 kilograms of dry wood substance per cubic meter. A charge of dilute acid is then injected at a temperature lower than that of the percolator contents, and the injected acid is heated by steam from the bottom until the desired temperature is reached. The solution is then pressed from the percolator by applying steam to the top of the charge. This operation is repeated for a total of up to 20 cycles, with 0.8 percent sulphuric acid at temperatures increasing to a maximum of 184° C. From 10 metric tons of wood approximately 120 metric tons of liquor with a concentration of 5 to 6 percent sugar is obtained.

The Scholler plant at Ems, Switzerland (*42*, *54*) has proved very successful. It has apparently operated at better than design rating to produce about 52 gallons of absolute alcohol per ton of wood. The Ems plant is like the German plants, except that it uses a shortened percolation schedule and the calcium sulphate is removed from the neutralized wort by a centrifuge. The sludge is washed on a drum drier.

Production data obtained for the German plants following World War II showed unfavorable operation, but the wartime difficulties certainly had an adverse

effect. The Swiss plant at Ems had fewer difficulties of this sort, and evolved into a well-running operation. The best information now available indicates that the Scholler process can operate essentially as claimed, to produce alcohol in yields of 50 gallons or more per ton of dry wood. The report by Rockstroh presented at Stockholm (*8*) supports the view that engineering problems are well in hand.

The recent work on wood-sugar production by a percolation process in the United States has been described (*44*). In 1935, the Cliffs Dow Chemical Co., of Marquette, Michigan, obtained the rights to the Scholler process in the United States. A modified Scholler process was studied on a pilot-plant scale, but it was not used commercially. In 1943, the War Production Board recommended that the United States Forest Products Laboratory study the Scholler process in the pilot-plant facilities at Marquette, Michigan. The Vulcan Copper and Supply Company was requested to follow the pilot-plant operation and to prepare a process report that could serve as a basis for the engineering design of a commercial plant. As a result of these investigations, the War Production Board recommended that a commercial plant using the modified Scholler process be constructed and operated as insurance against possible future grain shortages. In 1944, construction was begun on a plant at Springfield, Oregon.

The preparation and fermentation of wood hydrolyzate at the Springfield plant was carried out successfully. The production of sugar, however, presented some problems, none of which were considered fundamental to the process. Part of the difficulties could be accounted for by the history of the plant. When the war ended, the contract for the uncompleted plant was cancelled by the Government. Construction was later resumed, and after some engineering compromises for the sake of economy, the plant was completed sufficiently in February 1947 to allow partial operation.

Marked changes in the Scholler process, particularly in speed of operation, were necessary before it could be considered acceptable under American economic conditions. These modifications were studied in a small pilot plant with no intermediate step to the full-scale plant. For limited periods during test operations, the yield of sugar on the basis of bark-free wood processed was up to design value. Consistent operation however, was not realized.

Following the war, the Tennessee Valley Authority became interested in wood saccharification because of the large amount of non-timber grades of wood and waste available in the area. In 1952, Gilbert and his co-workers reported (*15*) on pilot-plant studies carried out in co-operation with the Forest Products Laboratory. The purpose of this work was to prepare molasses in quantity for feeding tests and to improve and simplify the hydrolysis process. An economic analysis showed that in favorable locations in the United States, the production of wood-sugar molasses for animal feeds would have been profitable during several of the postwar years. The risks involved and the modest profit obtainable make the process a borderline proposition. A more recent economic evaluation of the process as developed at the Forest Products Laboratory is given by Harris and Lloyd (*33*).

The hydrolysis of wood in a percolation process using sulphur dioxide as a catalyst has been discussed recently by Ant-Wuorinen (*1, 2, 3*). The process differs from that of Scholler in being more rapid and in causing less decomposition of the sugar. The process has been carried through extensive pilot-plant tests.

Fouqué (*11*) has patented a process for the dilute-acid hydrolysis of wood using the percolators in the manner of an extraction battery.

Of the dilute-acid percolation processes which have been proposed, only the Scholler process, as followed in Germany and Switzerland, has stood the test of extensive industrial application.

Strong acid processes for wood saccharification

A number of proposals for the hydrolysis of wood fall into the classification of strong acid methods. These methods are characterized by the use of large amounts of concentrated acid which bring about extreme swelling or solution of the cellulose. This serves to break the bonds which hold cellulose in the crystalline state and make it highly resistant to ordinary dilute acid hydrolysis. After extreme swelling or solution, and partial hydrolysis, the hydrolysis must be completed in dilute acid solution.

The very early work on cellulose saccharification made use of sulphuric acid. With improvement, as in the Giordani-Leone method, this process has much in its favor. The Giordani-Leone process (*16*) and the plant built in Italy during World War II were described by Centola at the Stockholm meeting of the Wood Chemistry Panel (*8*).

Wood is given a prehydrolysis with dilute acid to remove the hemicellulose. The dried residue is treated with 60° Bé sulphuric acid in an edge runner. This mixture is then diluted with the prehydrolysis liquor, and heated to complete the hydrolysis.

The plant operations were stopped by the war before satisfactory operating data were obtained. Centola, however, lists the following advantages and disadvantages of the process:

"*Advantages*

1. high yield of alcohol;
2. recovery of furfural and eventual other by-products such as acetic acid and ethereal oils;
3. possibility of working with sawdust as well as with chips.

Disadvantages

1. high consumption of acid;
2. necessity of solving the problem of placing the large quantities of calcium sulphate."

Hydrofluoric acid has received some attention as a reagent in wood saccharification (*12*, *36*). The lignin residue resulting from this process was at one time believed to be a promising raw material. A discussion at the Stockholm meeting of the Wood Chemistry Panel brought out the view that this process had not given good results.

In the process developed by Guinot (*18*), hydrolysis of cellulose is accomplished by means of formic acid in the presence of sulphuric acid. At 75 to 80 degrees, hydrolysis is completed in about two hours. Yields are said to be high.

The only strong acid method which has had any degree of commercial success is the Rheinau or Bergius method (*4*) using fuming hydrochloric acid. In 1940 a full-scale plant using this process was built at Regensburg, Germany. The following description of the operation was obtained following World War II (*45*):

> " Wood is hogged to chips not more than 1 centimeter in the long dimension, and conducted by a pneumatic conveyor to a Buttner rotary drier... Waste stack gas and the wood move parallel through the drier, and the moisture content is lowered to 6 percent. The wood is then loaded into 50-cubic-meter digesters lined with rubber- and acid resistant brick and extracted with 50 percent (by volume) hydrochloric acid. There are two parallel batteries of 14 extractors, half of each being extracted with concentrated acid, and the other half with water. The total time cycle per digester is 55 hours. As a result of the countercurrent extraction, with acid, a syrup is obtained consisting of water with 32 percent sugar, and 28 percent hydrochloric acid. This syrup goes to an evaporator system operating at 30 to 44 millimeters at 40° C. where the sugar concentration is raised 60 to 63 percent and the acid concentration lowered to 2 to 5 percent. These evaporators have separate heaters in which syrup circulates inside of porcelain tubes. The head of the heater is of rubber-lined steel. Steam is then injected into the syrup to reduce the acid concentration. The carbohydrate in solution at this point consists primarily of oligosaccharides, and in order to convert it to monosaccharides it is " inverted " by diluting and boiling. The residual acid is sufficient to catalyze the hydrolysis. The product is neutralized with lime and used for the production of yeast. The substances in solution consist of 70 percent glucose, 10 percent pentose, and 20 percent calcium chloride...
>
> The recovered acid, and the dilute acid washings pass to an acid recovery system where water is removed. This is accomplished by the addition of calcium chloride which increases the concentration of HCl in the gas phase. Water is continuously removed from the calcium chloride in the same apparatus. Conditions in this piece of equipment are extremely corrosive, and the operation is troublesome. The temperature is 145° C. In order to resist such conditions—high temperature, high acid concentration, and the presence of calcium chloride—the apparatus is lined with rubber and a double layer of brick. The heating tubes are of copper plated with gold or platinum.
>
> Equipment was being installed at this plant for the prehydrolysis of wood previous to its use in the Bergius process. Three 100-cubic-meter cookers consisting of steel lined with rubber and acid-resistant brick were to be loaded with 10 tons of wood and hydrolyzed with 100 cubic meters of 1 percent hydrochloric acid at 127° to 128° C. for four hours. A pump was to be used to provide outside circulation. The residue was then to be washed with water and dried... This plant, at the time of investigation, was getting ready to produce crystalline glucose from wood sugar. By using a dilute acid prehydrolysis the crystallization can be made much easier by removing sugars other than glucose. The prehydrolysates are satisfactory for yeast production. "

At the Rheinau plant, ion-exchange equipment had been installed and found to give syrups producing high yields of crystalline glucose (*45*). These modifications have recently been evaluated by Schoenemann (*8*).

General Problems of Saccharification Processes

The problems associated with the development of an economic saccharification process for cellulosic materials are numerous and complex but they appear no more difficult than those which faced many of the present chemical industries during their development. The saccharification processes developed to date have met these problems in various ways but in none has complete cognizance been taken of all the difficulties, with the result that none have been economically successful without subsidy. The following discussion will cover the major points that should be borne in mind while weighing the merits of proposed processes and also point the general direction in which research could be done.

The cellulosic raw materials may be broadly grouped into two classes: agricultural residues, which are harvested annually, and wood residues, which may be harvested continuously as desired. Both are available in continuous supply at low cost in the locality where they are grown. However, the annual crops usually are an expensive raw material when the cost of collection and storage is considered. Most of them also have a very low bulk density and large equipment and facilities are required. Annual crops have a further disadvantage in being subject to seasonal variations which require minor process variations. Wood is superior as a raw material in the general aspect to the annual crops but it too has disadvantages. It has a low bulk density, and the cost of handling and pre-

paring wood for the saccharification step is high, even when using the best methods and equipment available. For instance, the handling of logs and conversion to chips in the Scholler process amounts to approximately one-half cent per pound of sugar produced (33).

The process should be matched carefully to the physical and chemical nature of the wood available. The strong acid process sets limitations on the raw material; sawdust often available at low cost (including handling) is unsuitable. Any process which requires bark-free chips incurs a large increase in raw material cost.

The bulk density of wood is an important factor in the plant cost. Saving could perhaps result from the development of a continuous process.

The only practical path from cellulose to sugar appears to be acid hydrolysis and this fact requires that all processes use acid at least throughout the hydrolysis step. This is a critical point for consideration, as the type of acid and its concentration has a most important effect on plant cost. In the strong hydrochloric acid process, the major portion of the plant must be acid-resistant and estimates of plant cost (*8*) indicate a depreciation cost amounting to at least one-half cent per pound of sugar production on the basis of a large plant. This amounts to more than $200 of plant investment per annual ton of product, putting it in the class of expensive chemical plants. The plants using dilute acid require much less corrosion-resistant equipment and investment costs are somewhat less than half those quoted above.

Plant heat requirements depend largely on the end use of the hydrolyzate. In the case where the product is crystalline glucose or molasses, the heat load is enormous. In the Bergius process, heat is required to recover the strong acid used for the primary hydrolysis, while in the dilute acid process the main consumption is in the evaporation of the dilute solutions to molasses. Methods for increasing the sugar concentration in the hydrolyzates of the dilute-acid process have been employed by Cederquist (*52*), and this gives an economic advantage to the dilute-acid process. In the event that the sugar is to be used in solution for the production of yeast, alcohol, or other product easily separable from dilute solution, the heat load is greatly decreased, giving dilute-acid processes a decided advantage over strong-acid processes.

Chemical costs for the dilute acid processes are small, amounting to less than one-fourth cent per pound of sugar. In the strong acid process, they become significant, being estimated by Schoenemann (*8*) as more than one-half cent per pound of sugar produced even after full advantage is taken of modern recovery methods. The chemical cost of the strong sulphuric acid process makes it unattractive except under certain circumstances where the acid might have further use. This is considered in a later portion of this paper.

Considering the high costs of handling the raw material, the chemical costs and the heating load, it is apparent that every effort should be made to obtain full utilization of all the products available and these should be obtained in the highest possible quality compatible with cost. No commercial ventures have succeeded in such utilization. In no case has the lignin, which amounts to 20 to 30 percent of the dry wood substance, been used successfully other than as fuel. The hemicellulose fraction in some cases has been recognized as needing much milder treatment than the resistance cellulose, but no advantage has been taken of the fact that at least one unique chemical, furfural, may be obtained from this pentosan fraction. In most cases the hexosan sugar product has been utilized as a crude molasses containing large quantities of unknown impurities. Some of these undoubtedly could be profitably removed as higher priced organic chemicals, resulting in a twofold gain. In the case of the strong acid process, a high-quality sugar fraction is obtained. There has recently been proposed (*8*) a scheme for manufacturing crystalline dextrose which would market approximately 55 percent of the sugar product as food, the rest being marketed as molasses. The production of high-quality sugars from dilute acid wood hydrolyzates is poorly understood and should be the subject of research. Cederquist (*52*) has suggested a method for purifying the sugar by the addition of sodium chloride which forms a binary crystal with glucose. The yields of sugar from all processes are high. New research could profitably be done in the direction of increasing the yield of total products.

Waste disposal problems in an efficient saccharification process could be made small; molasses for stock feed and the concentration and burning of most of the other unwanted organics would solve most of the problems at moderate costs. One point worthy of mention here is the production of alcohol by the current Scholler process. The organic solubles and unfermented sugars in the still bottoms have an intolerably high biological oxygen demand. This is a case where the waste disposal problem would be nearly eliminated if the pentosan fraction were utilized.

Research and Investigations on Saccharification Problems

Research on the chemistry of the saccharification process

A study of the literature of wood saccharification shows that more effort has been spent on pilot plant studies and on technology than on the basic chemistry of the process. There is need for much useful chemical research particularly on the fractionation of cellulosic materials, the kinetics of cellulose hydrolysis and sugar decomposition, and in the modification of cellulose prior to hydrolysis.

The fractionation of cellulosic material. The prehydrolysis of cellulosic material, with separation of the nonglucose sugars, has long been recognized as a desirable step in saccharification processes. The concentration of the glucose into one fraction and the separation of pentoses and other sugars into another fraction

is favorable to improved utilization. Too little is known of the behavior of the various species in the prehydrolysis process, and data are not available to permit a choice of conditions giving the best compromise in yield and purity of the main glucose fraction.

As a parallel study, methods should be sought for the separation of lignin in a more useful form from the original cellulosic material, from the prehydrolyzed residue, or as a final product after total hydrolysis. A change in viewpoint might be needed here giving lignin the primary attention and considering carbohydrates the byproduct of the process.

The kinetics of cellulose hydrolysis and sugar decomposition. The study of the cellulose hydrolysis reaction is an essential part of any research program directed toward improving saccharification. There is an extensive literature on the kinetics of the hydrolysis of cellulose, both in regard to cellulose structure and in regard to utilization processes. Early research on the subject is reviewed in reference works on wood chemistry (*20*, *56*).

Early work on the kinetics of the dilute acid hydrolysis of wood was due to Thiersch (*53*) and Lüers (*34*) and was concerned with the development of the Scholler process. The dilute acid saccharification process was shown to be a consecutive first-order reaction. Later work at the Forest Products Laboratory confirmed these facts and showed that the two reaction rates are affected differently by changes in acid concentration and temperature (*23*). High temperature is favorable to high yields of sugar. This fact opened the possibility that a rapid two-stage process could give yields comparing favorably to those obtained in more elaborate processes. A report by Cederquist on a two-stage process developed in Sweden during World War II lends support to this view (*52*).

Work carried out in Australia by Kurth and others (*31*) and Foster and Wardrop (*9*) adds valuable information in the field. Very extensive research has been carried out by Kobayashi on *The Kinetics of Wood Saccharification at Lower Temperatures with Dilute and Strong Sulphuric Acid* (*27*). This paper describes the effect of a very wide range of acid concentrations and temperatures on the rates of cellulose hydrolysis and on the decomposition of all the sugars commonly found in wood. It is on the basis of such work as this that we must expect to devise new and improved processes.

Modification of cellulose prior to hydrolysis. Kinetics studies show that the simple dilute acid hydrolysis process, as ordinarily applied, suffers from an unfavorable ratio between the production rate and the decomposition rate of the sugar.

In theory, this ratio might be affected favorably by protecting the sugar (actually accomplished in the Scholler process by removal from the reaction zone) or by modifying cellulose in such a way as to increase its rate of hydrolysis.

The basic reason for the resistance exhibited by cellulose toward hydrolysis is its crystalline organization, hence reduction in the crystallinity of cellulose results in increased yield of sugar. Attempts to use ultrasonic energy for this purpose were unsuccessful. Extreme grinding of cellulose was effective in causing large changes in rate of reaction and in yield. While grinding of dry cellulose is expensive, some novel method combining extreme attrition and hydrolysis might be useful.

Irradiation with cathode rays causes chemical changes in organic materials. The cellulose crystallite surface is not a barrier to the rays and chemical changes are brought about throughout the crystallite. This has the effect of increasing the accessibility of cellulose and hence increasing the rate of hydrolysis. Such increases in rate of hydrolysis are brought about at the expense of conversion of some carbohydrate to noncarbohydrate material. The net effect, however, is very favorable.

Large changes can be effected in the crystallinity of cellulose by treatment with amines. The potential usefulness of such a process has not been evaluated in the field of wood saccharification. It should be emphasized here that there is an urgent need for more research of the sort which broadens our understanding of this problem, irrespective of immediate practical application.

Improvement in cellulose hydrolysis technology

There are a number of aspects common to all wood hydrolysis processes which present serious economic obstacles. These have to do with chemical costs, wood procurement, wood storage, and wood handling. In the plant, corrosion and heat load are serious problems. The hydrolyzed residue presents handling problems. All of these points can benefit from novel and improved processing techniques. Schoenemann in a recent publication showed that many of the technological problems which contributed to previous uneconomic operation of the Bergius process could be rectified. He points out that, in Germany, the most practical end product of wood saccharification is glucose. In order to obtain a maximum of crystalline glucose, the final solution must be as pure as possible. This is accomplished by a prehydrolysis of the wood to remove extraneous carbohydrates and by the use of ion exchange to purify the final sugar solution.

The heat load of the Bergius process and the acid loss can both be reduced by taking full advantage of vapor-pressure relationships in the water-glucose-hydrogen chloride system. These points and others have all been covered thoroughly by Schoenemann in a brochure (*47*) and in a paper presented at Stockholm (*8*). There is little doubt that great improvement can be effected in the Bergius process by taking full advantage of Schoenemann's proposals.

The studies carried out by Kobayashi in Japan on the kinetics of wood hydrolysis and prehydrolysis were paralleled by other studies on the technology of wood saccharification. Sawdust was treated with

strong sulphuric acid using expeller type impregnators to give high yields of sugar. The economic optimum appeared to result from using equal parts of wood and sulphuric acid. The sulphuric acid in the process was then used for the production of ammonium sulphate or phosphoric acid effectively cancelling out the cost of catalyst acid and neutralizing agent in the strong acid saccharification process.

The reports of Kobayashi (*26*, *28*, *29*, *30*) contain extensive data on the decomposition rates of sugar in sulphuric acid, in phosphoric acid, and in aqueous ammonia solutions. Material balances are presented for the various processes. Similar studies employing strong sulphuric acid were done in the United States on the hydrolysis of corncobs (*15*).

Direct production of materials other than sugar by hydrolytic processes. The production of crude or refined sugars from cellulosic residues has the advantage of an unlimited market for the product. There is the disadvantage, however, of low and variable price, particularly for crude molasses.

By a simple modification or extension of the hydrolysis process, the primary products can be furfural, hydroxymethyl-furfural, levulinic acid, and formic acid. Furfural is a chemical with an established and growing market and it is obtained exclusively from pentosans. There is no large market for hydroxymethyl-furfural, levulinic acid, or formic acid, but markets might be created with an established source of supply. These materials can be made as the only products of a wood hydrolysis plant, or they can be made from the prehydrolyzate only, while the glucose-rich wood sugars are used for other purposes. Additional research is needed to establish the conditions required for their efficient production, or to minimize their formation during hydrolysis when sugar is the desired product.

Summary and Discussion

Wood saccharification is seen to have many facets with many possible combinations of process and product. No comparison of processes is possible without specifying the place where a plant is to be located and the purpose it is to serve.

Thus in some locations the production of refined glucose from wood might be an attractive proposition. In the United States, such a process would merely reduce the consumption of corn, a commodity already in surplus supply and selling at a price controlled by the Government. Similarly, chemicals from cellulosic residues might find a ready market in the United States but in underdeveloped areas they would have no value.

As another example of the hazards of generalizing about saccharification processes, the cost of the acid in the strong sulphuric acid method of saccharification appears prohibitive, but when the acid serves the double purpose of saccharification and the production of ammonium sulphate or ammonium phosphate fertilizer, the process deserves more attention (*26*, *28*, *29*).

In directing a research program on the saccharification and chemical utilization of wood residues, the following points are worthy of special consideration.

Present evidence indicates that no truly simple saccharification process can be anticipated in the foreseeable future. Any efficient plant must be large, relatively complicated, and will require a high level of technical skill in its management and operation. In these respects, wood saccharification plants will be similar to modern well-operated chemical plants.

All evidence suggests that wood hydrolysis processes cannot become important until fuller utilization of the incoming raw material is realized. No single product is sufficiently valuable to pay the cost of raw material collection, handling, and processing.

The immediate outlook for wood saccharification is not highly encouraging. Available processes are suited mainly to special situations. Processes of greater general utility should be developed. Extensive and well co-ordinated research is required to accomplish this end.

The technology of existing processes might be improved, but it is important to encourage work on new techniques and new approaches to this long-standing problem.

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Forestry Extension Services in the Federal Republic of Germany

by Ulrich Hahn
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In forestry as in agriculture, appropriate professional training and an efficient extension service are, especially with regard to farm woodlands, the best means of raising productivity. In recognition of this fact, a Forestry Extension Service, closely connected with the organization of the Agricultural Service, has been built up in the Federal Republic during recent years.

There are 670,000 farms in the Republic combining agricultural and forest areas and the latter make up as much as 64 percent of the total forest area, i. e., 4.4 million hectares of woodland. The proportion of cultivated to forest land on these farms averages about 3 : 1. Earlier forest policy failed to take this factor of combination into account and measures taken were restricted solely to the forest areas. Now it has become necessary to give attention to the recognized requirements of both agriculture and forestry and to build up a suitable type of Forestry Extension Service accordingly.

In the North Rhine-Westphalia District, for instance, the tasks of the Extension Service are to render the following assistance, while fully respecting the rights of the owners of woodlands:

1. making woodland inventories and appraisals of the growing stock, and giving advice on management plans and silvicultural practices;
2. *a*) raising productivity, first through the formation of forest co-operatives; since really profitable forestry can only be practised on areas of a certain minimum size, it is an important task of the Extension Service, by explanation, advice and assistance, to promote the establishment of forest co-operatives and help to put them on a sound business footing;

   b) promoting useful measures such as the conversion of coppice to high forest, use of fertilizers, afforestation of waste land, making plantations outside the forests, and generally sponsoring good land use;
3. promoting better silviculture and utilization, by advising on appropriate silviculture systems and correct cultivation methods, purchase of attested forest seeds and plants, proper thinning and cutting practices, drawing up of simple working plans, sorting and utilization of the harvested timber, proper work methods and prevention of logging and hauling losses;
4. controlling over-cutting and advising on the change-over from one kind of land use to another;

Figure 1. *Agriculture goes hand-in-hand with forestry on a farm near Bad Godesberg, typical of the kind served by the Forestry Extension Service.*

FIGURE 2. *Small bus fitted with tools and equipment for demonstrations given in the field by "flying teams" of the Extension Service.*

FIGURE 3. *Demonstration of one-man power saw to farmers by members of a mobile extension team.*

5. Dissemination of the latest technical information: an essential part of the work of the Extension Service is to spread technical knowledge and increase the efficiency of the woodland owners as well as their understanding of forestry problems, for the improvement of farm woodlots and small forests is basically a problem of education.

Organization of service

For reasons of economy the Forest Extension Service has hitherto been linked to the existing official forest administrations which cover the expenses involved. It is intended, however, since the service works solely for the benefit of private owners, that they should themselves take over the financing. The woodland owners are likely to be eager to employ their own extension officers once they have realized the usefulness and advantages of the general Forestry Extension Service.

Since the extension officers have a wide area to cover and must get about quickly, cars or motor bicyles have been put at their disposal. Moreover, additional foresters have had to be taken into employment because more personnel were needed than the forest administration could release for special work.

Southern Germany

In southern Germany, owing to the different economic structure, the Forestry Extension Service is handled differently. In Baden-Württemberg, for instance, special "flying teams" have been set up, and the result has been very profitable. These advisory teams consist of one junior forest-master, one district ranger and two to three professional loggers, working together and giving demonstrations. The main stress is laid on teaching techniques and giving instruction in the sorting of timber and marketing. The work of these teams has been highly appreciated. During last spring the service was especially successful in southern Germany when strong winds resulted in a large amount of fallen timber having to be quickly cleared so as to prevent serious damage by pests, such as bark beetles. Quick and efficient action was taken by the Extension Service and the problem was solved.

In Bavaria, which has a different system of land ownership, no special advisory teams have been established. Here the main task lies in making inventories of private woodlands and this is combined with extension work.

Education of woodland owners

In general, however, assistance rendered by extension officers is not limited to technical forestry problems but involves also the practical education of woodland owners and especially farmers. Besides this, the foresters employed by private owners are also given training in special courses at forestry schools; forestry training at agricultural schools is to be increased.

Pamphlets and leaflets on forestry topics are issued periodically. These illustrated leaflets are written in easily understandable terms, with the aim of arousing and keeping the interest of woodland owners. Railway carriages have been transformed into training workshops and small buses have been equipped with the latest tools for felling, planting and repair work, so that practical demonstrations may be given at the actual place of work.

Extension work requires well-trained foresters who have initiative and a good understanding of psychology. It raises many problems, but it is a new and very rewarding task for which only the best men are suited.

Control of Brush and Undesirable Trees

by Arthur W. Sampson, Professor of Forestry Emeritus,
and Arnold M. Schultz, Associate Specialist, School of Forestry, University of California

This article represents the first section of a paper on equipment for control of brush and undesirable trees which has been prepared at the request of FAO. The further sections of the paper will appear in succeeding issues of Unasylva. *The whole series, when completed, will be made available under a separate cover.*

Much of the earth's surface is covered with brush. It is difficult to estimate accurately the area which is at present dominated by scrubby vegetation. Many of the major brushlands of the world are climax, that is, they constitute vegetative cover that has changed little in composition under existing conditions of climate, soil, and fire. Other brush associations are subclimax such, for example, as stands that occupy a forest site for a relatively short time after a fire or logging operation, but are suppressed when the forest becomes re-established. Still other brushlands are a result of invasions on lands which may never before have supported brush. By slow incipient migration into sites of good quality and by rapid aggregation, often favored by cultural, climatic, and weather change, such brush stands become the most important from an economic standpoint even though they may be far less abundant than the climax brush areas.

A partial estimate of the world's brushlands may be made from statistics provided by FAO in *World Forest Resources* (*17*).[1] In this compilation, many of the 190 countries and territories listing their land resources failed to separate brush land from deserts, rock and sand, and swamps and bogs. However, this study points out the prevailing attitude of considering brushland as wasteland with little potential for agricultural production. About three million square miles of brushlands are tabulated — just a little smaller than the area of Australia. This does not include the brushlands of the United States, South America (except Venezuela), U.S.S.R., Australia, and most of North Africa.

In the United States alone, upwards of 500,000 square miles (129,500,000 ha.) of land are dominated by brush. This includes sagebrush, mesquite, salt desert shrub, chaparral, oak, and pinyon-juniper woodland. Many other square miles of forest, mountains, and grassland are infested with brush although it is not the dominant vegetation. Texas alone has 55 million acres (22,258,500 ha.) of mesquite, some 18 million acres (7,284,600 ha.) of juniper woodland, and over 20 million acres (8,094,000 ha.) of scrub oaks; Arizona and New Mexico each have about 10 million acres (4,047,000 ha.) of mesquite and about as many acres of pinyon-juniper woodland. Sagebrush occupies 96 million acres (38,851,200 ha.) of land between the Rocky Mountains and the Sierra Nevada. In California there are 19 million acres (7,689,300 ha.) of chaparral and woodland and 2.5 million acres (1,011,750 ha.) of commercial forest land that is producing little more than brush. No doubt similar figures could be quoted for other countries.

Far from all of the world's brushy growth is lacking in economic value. In many localities brush serves as important food for livestock. In areas set aside primarily for grazing, the aim should be to maintain a proper balance of brush and grass. Semple (*38*) estimates that on the savannas fully as many domestic grazing animals and big game obtain their sustenance from browse of shrubs and trees as from grass. Included in this estimate are the shrublands of Africa, the maquis of the Mediterranean and the Near East, the heather moors of northeast Europe, the thornwald of South Africa, and the various brushes and trees of Australia and western United States.

Brush clearing and conversion to grassland, forest, or cropland is going on, though slowly, largely because of lack of suitable machinery, low quality of much of the land, excessive costs compared to low returns, and to insufficient knowledge of the ecology of the brush species involved.

Most of the brush clearing acreage is being done for range improvement. The vast expanses of range lands at the lower and intermediate altitudes lend themselves to massive clearing operations with heavy machinery. Concomitant with the removal of the brushy cover is the restoration of native herbaceous vegetation or the artificial seeding to grasses and legumes. Many of the mechanical devices for clearing brush simultaneously prepare a good seedbed for grasses. Besides providing more forage, other benefits of brush clearing are that the forage becomes more accessible to grazing animals, handling of livestock is easier, fewer lambs and calves are lost by straying, fleeces do not become snagged, seed sources of noxious brush species are restricted, and in many instances accelerated erosion is reduced when a grass cover has been established. Fire and chemicals are easy to use on rangelands because the woody plants are generally susceptible to these killing agents whereas most grasses are not. Large-scale or "broadcast" methods of application are consequently effective.

[1] The figures in parentheses refer to literature cited on pages 28 and 29.

Brush control in forests is practised to release crop trees for faster growth, reduce fire hazard, encourage natural reproduction or to facilitate planting and seeding. However, heavy tractor-powered machinery is difficult to use in forests where the terrain is rugged and where desirable trees and seedlings are closely spaced. Smaller equipment is available for such conditions and not infrequently portable handtools are the most effective. Fire can be used to advantage under special conditions but with the present state of knowledge concerning its use it is hazardous. Chemicals also are effective but must be applied to individual plants, instead of broadcast foliar sprays, so that the desirable trees will not be affected.

Brush fields on level and fertile soils and on areas close to population centers are being cleared for agriculture, notably for nut and fruit orchards, grain and fibre crops, irrigated pastures and hay meadows. For such intensive use, the clearing job needs to be thorough. All stumps are removed and roots are dug out of the soil as these may later become hazardous obstacles to lightly built farm machinery.

Brushland clearing for cultural developments, such as rights-of-way for roads and power lines, irrigation ditches and drainage systems, buildings, and parks, is carried out with essentially the same kind of equipment but cost-benefit relationships are entirely different than for agricultural brush control work.

For the purposes of this paper no distinction is here made between shrubs and undesirable trees since the same principles apply, the main difference being chiefly a matter of size. Consequently, the terms brush and brushland control, unless otherwise defined, will include shrubs and/or trees. Control of weedy herbaceous plants is excluded from discussion as broad generalizations on this phase can be misleading. Development of equipment to eradicate crop weeds and other herbs has been going on for a long time. There is a vast literature on the subject. New developments of herbicides and spraying equipment, for example, have gained considerable momentum since the second world war, and a complete discussion of them today would be obsolete within a year.

Although the major emphasis in this paper is on equipment, certain non-mechanical procedures are discussed in order to round out the topic of brush control. The roles played by fire, chemicals, grazing management and certain biological factors are treated along with methods of mechanical clearing.

Factors Determining the Kind of Equipment to be Used

The method of brush control and the equipment to be used depends on the objectives of the control work, the expense that can be put into the operation, and the benefits that may be expected. The choice of method and implement also depends directly upon three physical factors; the kind of vegetation, the topography, and the type of soil.

Objectives of control work

A few examples will serve to show how the objectives of the control work influence the method and equipment used, irrespective of cost, vegetative type, terrain, and other factors. Additional examples are incorporated along with the descriptions of equipment.

Range improvement

Where the brush has little value as browse, it might be desired primarily to provide maximum crops of herbaceous forage for livestock. This involves eradication of the brush cover to favor grass establishment. The best machine to use is one that effectively clears off the brush and at the same time prepares a good seed bed for the grass (Figure 1).

Watershed management

Where it is desired to clear off the brush, the stems and leaves of the plants — the transpiring surface — are severed from the roots, but all roots are intentionally left in the ground to avoid disturbance of the surface soil except to the extent of providing a seedbed for a grass cover. A combination of mashing with a bulldozer to break off the brush tops, and burning to provide an ash seedbed may be used for this purpose, or perhaps any of the various brush chopping machines which leave a heavy layer of mulch on the soil surface may be employed.

Forest management

The objective might be fire hazard reduction. In well-stocked forest stands brush, dead trees, and slash can be removed with axes, chain saws, or portable circular saws. Small bulldozers (20 h.p.) can be used in the clearings (Figure 2). Frequently decadent brush plants can be pushed out by hand. Combined with prescribed burning during the wet season, the readily combustible material may be reduced, at least in some localities, with little soil disturbance or damage to timber (*42*). Or the objective might be the release of suppressed trees. In such cases ammate or hormone-type chemicals poured in frills around the base of woody plants, or girdling, and removal later with saw or axe, are effective methods. The first two are best because they prevent sprouting and thereby conserve soil moisture and nutrients.

Wildlife management

Improvement of the habitat for game may be accomplished by localized control of the brush. Manipulation of brush covers for browsing animals involves partial clearing and conversion to herbaceous vegetation in certain portions of the range. Frequently repeated removal of the mature lignified top-growth is necessary to insure a constant supply of young, succulent sprouts for browse, and protection from

wild-fires or other damage to the cover needed by the animals (7). Wildlife management practices may demand the planting and raising of shrubs where suitable browse is scarce. Bulldozing, burning, discing, reseeding, and selective chemical sprays, alone or in various combinations, have been used limitedly in meeting the objective (Figure 3).

Cost of operation

Intimately related to the specific problem of kind of equipment to use on a particular area is the subject of economics of brush control. This subject can be outlined as a list of questions which a landowner must ask himself when he plans the management of his brush land.

1. Is it physically possible to convert the present vegetation to a more desirable type?
2. What will the land produce when the brush is cleared and how much money has to be put into the operation to come out with significant or profitable returns?
3. What degree of clearing should be made to attain the original objective and to insure economic returns?
4. What other land uses must be considered, and is the brush control work which is necessary for the primary objective complimentary to these other uses?
5. What equipment, labor, time, and money is available for the brush clearing operation?
6. What is the final choice of method, considering the objectives and the characteristics of the area concerned?

Physical possibilities of brush control

It is only logical that the question: "Can it be done?" be asked before: "How much will it cost?" As far as the possibility of brush and tree *removal* is concerned, however; that question is becoming less important day by day. Modern equipment is approaching the irresistible force while vegetation remains as immovable as ever. Whether grass or grain or some more desirable form of the same shrubs can be substituted for the present cover, that is the most important problem at hand. It is conceivable that the present kind of vegetation on a site, whether brush or trees, may be the only kind that can grow there unless a drastic change is made in soil, climate, and plant competition. Research and experience determines whether this is true, and what changes must be made. Over a long period of time, research is cheaper than lay experience because its findings are basic and recorded.

Production, costs and profit on cleared land

The production on grazing land that has undergone brush control is expressed as weight of forage or as grazing carrying capacity, either in absolute terms or as increment over the production attained before brush conversion. The productive capacity affects the assessed value of the cleared as well as the adjoining uncleared lands of the same potential. This concept does not involve the original value of the land or the cost of the clearing operation.

The land manager must know the costs of alternative methods of controlling his brush as well as the returns from alternative crops that can be grown on the cleared land. Together with a knowledge of the present land value and its resultant worth, he plans his clearing

FIGURE 1. *Bulldozer and disc. The bulldozer blade breaks off and mashes the woody stems and the disc chops them up and incorporates the mulch with the soil. The soil is tilled, suitable for seeding. In the photo a 100 horse-power Caterpillar Diesel D-7 tractor is pulling a Towner offset disc.*

Caterpillar Tractor Co., Peoria, Illinois

FIGURE 2. *Brush clearing in the forest. A small bulldozer mashing manzanita in preparation for a prescribed burn under second-growth ponderosa pine trees in California. Small dozers, up to 40 horsepower, are powerful enough to do the job, yet can easily be maneuvered between the trees.*

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FIGURE 3. *Brush control for wildlife management. Strips of chamise have been double-disced and seeded to herbaceous plants in the north Coast Range of California. The standing brush provides cover for game; the grasses, forbs, and sprouts in the open strip are used by deer during the winter months and by quail the year round. Narrow bands give the greatest possible "edge" effect. Contouring prevents excessive erosion.*

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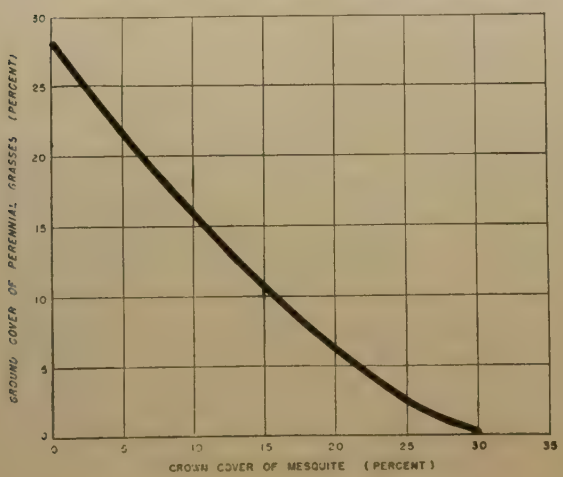
operation and subsequent management. If a brush field is located near an area of high population, would it be profitable for the owner to clear it partially for the purpose of growing timber and for recreation? Another decision might be whether to allow native herbaceous vegetation to become established on the cleared land — the cheap way — and raise beef cattle or to clear, till, and seed the area to choice pasture plants and raise dairy cattle. Timber and recreation might eventually give high returns but not for many years after planting; beef may not gross as much income as dairy products near a city. Questions like those enumerated cannot be answered until the initial investment is considered.

FIGURE 4. *Relationship between percent of crown cover of mesquite and percent of ground cover of perennial grasses on southern Arizona rangeland.*

After Parker and Martin (*26*)



Degree of brush clearance for economic returns

Cattlemen who have been battling the brush on their ranges feel that every noxious shrub is taking up space, nutrients, and water that ought to be used by more desirable forage plants. This suggests a quantitative, linear relationship between the number of shrubs per unit area of land and the amount of forage produced. Such a relationship is shown in Figure 4 (*26*). As brush increases in abundance the area occupied by grasses declines.

The graph can be interpreted in another way: when brush is eradicated, the area that can be occupied by grasses increases. Interpolations made from the graph show that where brush has 12 percent crown cover grass density can be increased 100 percent (doubled) by removing the brush and, where the brush crown cover is 25 percent, potential increase of grass density is 1,000 percent. On the other hand, where only 1 or 2 percent crown cover of brush is present, maximum

increases of grass can be no greater than 3 or 8 percent respectively, by removing the few shrubs from the cover. Is this profitable? A control method which reduces the brush cover from 15 percent to only 5 percent, with a potential grass increase from 11 to 22 percent density (or 100 percent increase), may cost $5.00 per acre to effect. On the other hand, a more thorough method which removes all the brush gives 6 percent more grass density (or an increase of 150 percent), but may cost $20.00 per acre. Which is the more profitable method?

Admittedly, there are more factors involved than those represented by the simple relationship given above, but the example serves to illustrate the kinds of decisions that must be made by land managers who wish to clear brush.

Another example will show how costs, returns and effectiveness of brush control are interrelated (*26*). On an area in Arizona, mesquite control by the cheapest known method in 1947 cost $4.04 per acre. This control method was estimated to result in an average increase of beef production of 3.36 pounds per acre per year. When calculated on the basis of 17 cents per pound, which was the 10-year average price between 1941 and 1950, the value of this increased production is 57 cents. If the original investment of $4.04 is compounded at a 5 percent interest rate, the increased returns obtained from the mesquite control would liquidate the capital outlay in 9 years. Assuming that the control is effective for 25 years, its benefits would be available for 16 years after the investment was paid off. Again, several factors have been disregarded, such as the purchase price of additional cattle to stock the range as the carrying capacity increased, the compensating sale of old cows and bulls, and the effect of the gradual re-encroachment of brush prior to the end of 25 years.

If the mesquite control method were effective for a period less than nine years, it would be a losing proposition. This is why "broadcast" control burning, since it is relatively inexpensive, may be profitable for a range and livestock enterprise, whereas land cleared by a combination of grubbing, root-raking, and burning of brush piles may not return the investment unless intensive agricultural practices are followed.

Multiple uses of land

Although there may be one primary objective for a given brush control operation, usually one or more secondary values of the land are either benefited or harmed. In those brushlands that have been essentially unchanged for decades or even centuries, there is a reasonably stable balance between the vegetation and wildlife, soils, and ground water levels. Tampering with the vegetation upsets this balance but the change may be either favorable or unfavorable to society. It may be favorable for a while and gradually become detrimental or it may in time become more favorable.

The subject of soil and water conservation as it relates to land clearing practices is so important that a separate section of this paper is devoted to it.

The choice of certain methods aims to assure good conservation practice. For instance, crawler-type tractors are ineffective on terrain which has 50-percent slopes or steeper. This, then, automatically precludes disturbance on the steeper and poorer sites when mechanical clearing methods are used. Work done with wheel tractors is still more restrictive to better sites. Broadcast burning, on the other hand, does not provide this selectivity; updrafts on steep slopes may increase the effectiveness of the fire if adequate fuel is present, but a suitable vegetal cover may not become established before serious erosion has occurred.

In most cases where brush is partially cleared for range improvement, wildlife habitats are also improved. Burning or mashing of sprouting brush species provides good browse for deer, scattered unburned brush piles are excellent cover for quail, dove or other small game, and reduction of much of the transpiring surface may initiate flow of springs which have dried up as the brush cover became dense. The result is an increase in and better distribution of game. The increase in game on the range may not be worth a specific amount of money per acre but it may be subjectively a determinant of the method used in brush clearing. In some instances an increase of game may even be a nuisance; then methods which tend to discourage game should be chosen, such as complete clearing.

The many secondary benefits of brush clearing not only affect the parcel of land on which the work is done, but also adjacent lands and the community as a whole. Besides an increase in game, increase in usable water, fire hazard reduction, removal of insect and fungal hosts, and decreased invasion of brush species are other values which do not appear on the landowner's balance sheets but are not so intangible to his associates. Not all secondary effects are benefits. Erosion, gullies, and silt deposits do not stop at a property line. And it is unfortunate that the eradication of large tracts of certain kinds of brush may eliminate entirely the presence of many birds, mammals, insects and wild flowers which have tremendous inspirational and aesthetic value to a greater number of people than do larger herds of livestock.

Availability of equipment, labor, time and money

An efficient, brush-clearing operation cannot be planned unless proper equipment and labor are available. In the United States during the second world war, an opportunity for profitable brush clearing on rangelands was present because beef prices were abnormally high. However, steel was scarce, implement factories were engaged in making war materials, and labor, when available, was costly. Consequently, little mechanical work was done during those years.

The extensive brush fields of the world are too formidable to tackle with a grub hoe; on areas where heavy machinery cannot be purchased, large scale

land-clearing operations will be deferred, even though labor costs are cheap.

In addition to cost of labor a qualitative aspect must be mentioned. The skill of an experienced bulldozer operator — " cat-skinner " — compared to that of a novice, far more than offsets the higher wages that he receives. Wear on machinery is minimized; more brush is cleared per day; costs per acre are lowered; the job of clearing is more uniform; there is less disturbance of soil. Hence, availability of skilled labor is an important factor in the choice of method and its subsequent success.

Frequently the time allowable to complete a job will determine what method is to be used. Chemical sprays, for example, react slowly on certain shrub species. If it is desired to have the land cleared off within a few weeks so that a particular crop such as rice or cotton can be planted on time, the slow chemical method would not be satisfactory. The difference of a year in timing may change a venture from success to failure.

The initial investment in equipment and supplies is frequently the most important determinant of the method used. For example, the brushland plow and the bushwhacker, including the tractor needed for power, are expensive items, and a man with 160 acres (65 ha.) of brush cannot afford to buy them. He is better off to modify his own farm equipment, or to buy portable, second-hand equipment, or perhaps use fire followed by pasturing with sheep or goats. In localities where much brush clearing is done, persons who own equipment may be employed to do the clearing work on a contract basis. Whether it is cheaper to hire a contractor or to buy the equipment and assume maintenance and repair costs depends on the size of the job.

Final choice of method

The foregoing discussion has pointed out some of the considerations in choosing the equipment for brush control. Both qualitative and quantitative factors are involved, hence no single directive can be followed which can help to make the decision. Descriptions of equipment in the following section include notations on such attributes as effectiveness of kill, adaptability to terrain, effect on soil, availability, and approximate costs per acre. These notations are to summarized in a single Table in the Appendix, using various brush types as examples.

Kind of vegetation

The term brush denotes a woody growth form of smaller stature than a tree. Unfortunately, woodiness and size class, while expressing the similarity between the various shrubs of different species, do not indicate their diversity which makes a given brush cover difficult to control. Such characteristics as reproductive habits, depth of rooting, abundance, shapes, and brittleness

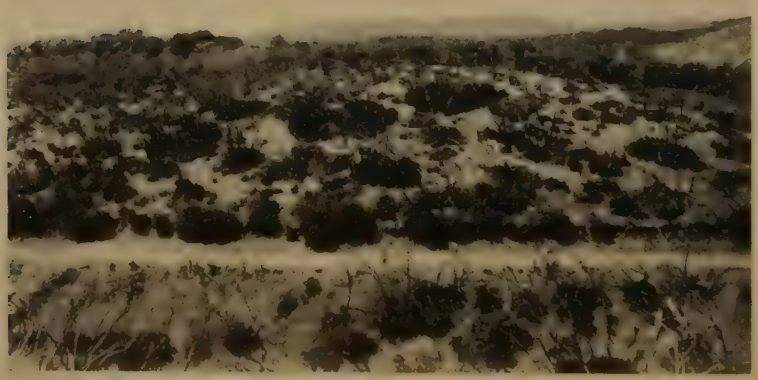


FIGURE 5. *Crown sprouting of chamise (upper) and scrub-oak (lower) after fire in the California chaparral. The dead, blackened stems or " snags " arising from each clump of sprouts indicate the former height of the plants. Over half of the shrub species of the chaparral are sprouters. Except where there is intensive browsing, pre-fire densities are re-attained in 5 to 8 years.*

University of California

of stems, and density within the various species necessitate different methods of attack for each brush type. In addition, the size of stems and height of plants are determinants of the kind and size of equipment to use. No generalization of the effectiveness of a given method of eradication can safely be made, except, perhaps, in a stand composed of an individual species. The three most important factors with respect to the brush cover itself are whether the plants crown sprout or not, the size of the stems, and the density the brush stands attain.

Crown sprouting versus non-crown sprouting

Many woody plants sprout from the crown — the junction between root and stem — after the top has been removed or killed (Figure 5). This characteristic is found in many families scattered through the plant kingdom and is diagnostic of neither genus nor species. In North America, two large genera, *Arctostaphylos* and *Ceanothus*, have species that do not sprout, some that sprout weakly, and some that are strong sprouters. Throughout its range bitterbrush (*Purshia tridentata*) is a non-sprouter but in several small localities sprouting forms have been observed.

The habit of crown-sprouting means that mere removal or killing of the top growth does not result in its eradication. Vigorous new shoots may arise from the crown and, since the root system is still intact, the plant soon resumes its former stature and density. Frequently the leaves of sprouts are larger than those on mature branches, hence water use may equal or exceed that of the original plant. The vigor of the sprouts depends on the amount of food stored in the underground organs. This is a clue to the method of control, to remove the tops when the food reserves in the crown and roots are lowest. Frequent removal of the sprout growth, so that more food reserves are translocated to the tops than are manufactured and stored in the roots, gradually reduces the vigor of the plant until it dies. This can be effected with a heavy concentration of browsing animals, such as goats, sheep, or deer, or by repeated burning, contact spraying or discing. Reburning is not always possible; succulent young brush plants do not burn readily unless they are sparsely scattered in dense dry grass fuel. Contact spraying is usually more successful when applied on vigorous plants, so that this method seems to become less effective with each repeated spraying. Bulldozing and discing also have their drawbacks in respect to sprouts because they are not brittle and spring back erect after the machine passes over.

The buds from which the shoots arise may be just at the soil surface or as much as a foot or more under ground (Figure 6). Any method that seeks to kill the plant completely in one operation must be one which removes all buds below the soil line (*15*). Various types of grubbing or sub-surface cutting equipment are used for this purpose. While time is saved by grubbing, soil disturbance is usually greater than with the " starvation " method described above.

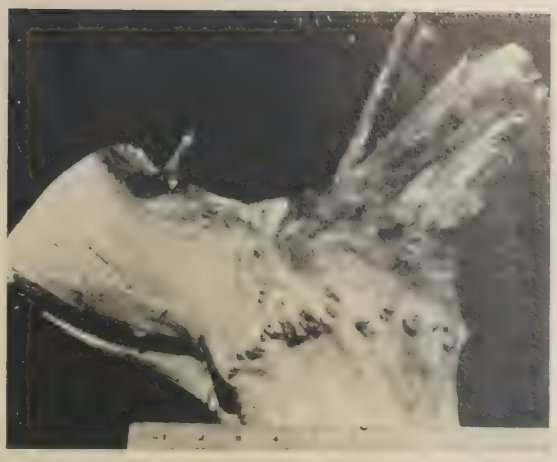


FIGURE 6. *Location of dormant buds on stems of two woody plants. Above, mesquite; right, sprouting juniper. In juniper the buds lie in a thick mass just above the soil surface whereas in mesquite they may be from 6 to 12 inches under ground.*

Soil Conservation Service

A somewhat different problem is encountered with the non-sprouting species. For example, the chaparral and maquis of the countries with Mediterranean climate, are comprised of " fire " species. Seeds of such species may be produced year after year but they do not germinate until a fire burns over the stand. It is thought that the heat cracks the seed coat or in some way makes it permeable to water. Scarification, as may be induced by bulldozing and use of certain other kinds of equipment, produces an effect similar to that to fire. This characteristic results in a paradoxical phenomenon: brush removal by fire or mechanical methods may result in brush becoming more dense than the original stand (Figure 7). In such cases it is imperative that follow-up management is practiced; these may be reburning, spraying, heavy browsing of seedlings, or reseeding to grass to provide competition (*36*).

Character and size of stems

The bigger the plants, the heavier the equipment needs to be to remove them, but there are a few exceptions to the rule. Certain trees are poorly rooted and can be pushed over without great effort. Brashy growth and brittle stems can be broken more easily than tough, springy stems even if the latter are found on smaller plants.

Two considerations to bear in mind when selecting equipment for clearing brush are the weight of the implement and the power needed to operate it. There is no handy table from which can be derived horsepower of tractor and size of disc when the average diameter of brush stems is known. This must come from the judgment of an experienced machine operator. Since the variables of objectives and costs, kind of brush, and character of terrain enter in, any recommendation applies to local areas only; consequently few examples are given in the literature.

In dense stands of California chaparral, where the brush consists almost entirely of small plants under 6 feet (1.8 m.) in height and 3 inches (7.6 cm.) in stem diameter. the most efficient bulldozer is one of 40 or 50 horsepower (*6*). Where the stand is dominated by medium-sized plants 6 to 12 feet (1.8 to 3.6 m.) or occasionally 15 feet (4.6 m.) in height and 3 to 6 inches (7.6 to 15.2 cm.) in diameter, a bulldozer of 40 to 50 horsepower is about at the lower limit of efficiency for mashing or uprooting. Where many of the plants are larger than 15 feet (4.6 m.) high and 6 inches (7.6 cm.) in diameter, other methods of clearing must be used to supplement bulldozing. The heavier tractors (80 horsepower and over) are powerful enough to mash down plants of this size but maneuverability is limited and much backing and turning is required.

In trees, size is a function of age. Young thin-barked trees are often easily killed by fire or by basal application of chemicals; mature trees are more resistant while old, decadent ones may be easily killed.

Frilling and notching for chemicals and girdling are methods in which a major portion of the cost involves work with an axe. Naturally, the larger trees have greater circumferences and consequently the cost per tree increases with its size.

Density of cover

In some forms of vegetation woody plants are sparsely scattered, such as savannas and woodlands. The trees and shrubs do not tend to aggregate, even after allowing sufficient time for seed dissemination. Supposedly the association of plants is stabilized. However, during periods of stress — drought, excessively wet periods, overgrazing, lack of grazing, lack of naturally occurring fires — the more aggressive, more tolerant, and usually least palatable species invade adjacent areas and thicken their stands. The encroachment and increase of mesquite in southwestern United States illustrates this process.

Mesquite reproduces by seed and it also sprouts from the crown. It is hardy and withstands drought by reason of its root system which may extend 50 feet (15.2 m.) laterally from the stem and 60 feet (18.3 m.) deep. Its growth form is plastic, mature plants varying from single-stemmed trees 50 feet (15 m.) tall to multi-stemmed bushes only 3 feet (0.9 m.) tall. The seed pods are palatable to livestock and game animals but a large proportion of the seed remains viable after passing through the digestive tract. The foliage is seldom browsed closely enough to hamper the growth of the plant. These characteristics of mesquite have allowed it to increase rapidly but insidiously.

The denser stands are difficult to clear. It takes more power and time to run machinery through it, and there is more wear on equipment than in lighter stands. The difficulty of control is lessened when airplane spraying of chemicals is employed. Here complete coverage of the area is imperative, providing uniform distribution, regardless of whether the infestation is heavy or light. For this reason incentive payments by the United States Federal Government to Texas ranchers, amounting to 12 cents per acre for each 1 percent infestation, has been made. Thus assistance for control of each acre of mesquite with a crown cover of 42 percent would be $5.00, which is the maximum allowance. Where the infestation is less than 1 percent, no payment is made. Thus there is a bonus for those land managers who clear their heavily infested range lands of brush, but none for the all-important stopping of initial invasion before the 1 percent density is reached. At this incipient stage of encroachment, the plants can be effectively and cheaply eradicated.

Density of brush is a determinant of method of brush removal in another way. Under the shade and competition of dense brush there is little herbaceous vegetation and consequently not much seed of grasses or other herbs. Therefore the method of brush clearing must be such that artificial seeding is possible and successful.

Topography

The character of the terrain is important to brush control from three standpoints: it determines whether the land is accessible to or can be traversed and worked by machinery; it determines the usability of the land as range, cropland or watershed; and it affects the amount of erosion that may take place after brush clearing.

Steepness of slope is the most important aspect of topography in this regard. The critical nature of the gradient, however, is modified by different lengths of slope, erosibility of soil, type of cover, and brush control methods.

Slopes with gradients less than 30 percent (3 feet [0.9 m.] vertical for every 10 feet [3 m.] horizontal) are well suited to grazing and forestry practice. At the lower range — less than 15 to 20 percent — culti-

FIGURE 7. *Brush seedlings appearing after a fire in woodland-grass chaparral where many of the shrubs are non-sprouters. The seedlings in the foreground are wedgeleaf ceanothus. In the background are yerba santa sprouts and fire-killed interior live oak trees. During the first year after fire, brush seedlings frequently number 250,000 per acre or more but many will die within one or two years. About 500 to 1,000 mature plants constitute a full density stand.*

University of California

vation is usually not hazardous. There is likely to have been little recent geologic erosion from such moderate slopes, consequently the soils are apt to be deep and fertile. A good index to the fertility is the size of the brush or growth rate of the trees.

Moderate slopes are conducive to almost any method of brush removal. Ground equipment can be used if there are no rock outcrops. Controlled burning can be employed providing enough natural barriers are available to make it safe and convenient. Chemical control, either by air or on the ground, is feasible. Control by grazing management is easy on moderate slopes since the lush grass on fertile soil is responsive to manipulation. Erosion hazard is likely to be minimum following any rational clearing technique.

Where the terrain has a high proportion of steep slopes, great care must be taken in selecting sites where brush control is possible, as well as suitable. Slopes above 50 percent are too steep to work with implements which disturb the soil cover. Crawler tractors have enough power and traction to go up the steepest grades but gullies will follow in the wake of the tracks; on the other hand, if the slope is too steep, the tractor may tip as it travels along the contour. Brush control methods are limited almost entirely to broadcast burning, chemical spraying by aircraft, or to hand methods.

On such steep slopes there is the problem of establishing a grass or tree cover on thin soils, and if grass can be established, however sparsely, slipping of soil, trampling and sliding of grazing animals, and the loss of fertility is always present. Generally, wildlife and watershed management will be the highest use to be made of such areas and there should be no complete manipulation.

In between these extremes, roughly in the range of 20 to 50 percent slope, is the place where the most cogent decisions need to be made regarding choice of methods for brush control. The land is not as valuable, potential production is not as high, and costs of clearing will be greater here than at lower elevations. At the lower limits of this range, bulldozers, discs, and other implements can be operated efficiently; at the upper limits, controlled burning and chemical spraying are the best methods. On rugged terrain there occurs the greatest heterogeneity of soil conditions, vegetal cover, precipitation patterns, and land use potentials. Sites must be carefully selected both from the viewpoint of: What can be done? and: What can be done profitably?

Kinds of soil

There are as many different soils as there are combinations of different climates, vegetation types, relief patterns, parent materials and geological histories. Brush and trees occur on a large number of different soils and on many of them these plants are thought of as being undesirable. Consequently, no hard and fast rule can be established in deciding on which soils brush control is feasible. However, several general characteristics of soils are important to keep in mind in deciding whether and how to clear brush.

Depth

The thickness of the solum is most important because it determines what the land use potentialities might be after the brush is cleared. Deep soils are desirable for most crops. It is easier to convert brushland to grass or trees when the soils are deep because there is a greater store of nutrients, more water can be held, and plants are more firmly anchored.

Erodibility

The ease with which a soil will erode is a function of its structure and texture. Soils with such profile characteristics as non-structural sandy topsoil with clayey subsoils erode readily. It might be best to leave them alone unless a better vegetative cover can be provided before erosion takes place. A bare soil is apt to erode no matter what structure it has.

Fertility

Even shallow soils may be fertile. The relatively young soils derived from rocks of recent uplift have high nutrient content. The use potentials of such soils will be high. The fertility factor is related to erodibility: rich soils produce more cover and may provide a crumb structure in the upper horizons. Almost as important as the innate fertility of a soil is its potential fertility. Fertilization of cultivated crops is an old practice, but its possibilities on range lands and forests are being studied. Soils which respond to fertilizers should be given priority to those which do not in a brush control program.

Rockiness

Boulders and rock outcrops on the soil seriously hamper the use of equipment in brush clearing and subsequent management. Machinery must be built more sturdily, yet breakage is common and expected. Certain types of equipment, such as the pipe harrow, described later, have been designed especially for such soils. Where rocks make up a considerable proportion of the ground cover, crop yields are naturally low so that little profit is realized.

(*This article is to be continued in subsequent issues of* Unasylva).

Common and Botanical Names of Species Mentioned

Annual or Italian rye (*Lolium multiflorum*)
Bitterbrush (*Purshia tridentata*)
Bur clover (*Medicago hispida*)
Cereal rye (*Secale cereale*)
Chamise (*Adenostema fasciculatum*)
Cheat brome (*Bromus mollis*)
Common alfalfa (*Medicago sativa*)
Coyote bush (*Baccharus pilularis*)
Creosote bush (*Larrea tridentata*)
Crested wheatgrass (*Agropyron cristatum*)
Fescues (*Festuca* spp.)
Hardinggrass (*Phalarus tuberosa*)
Interior live oak (*Quercus wislizenii*)
Intermediate wheatgrass (*Agropyron intermedium*)
Juniper (*Juniperus* spp.)
Ladak alfalfa (*Medicago saliva ladek*)
Manzanita (*Arctostaphylos* spp.)
Mesquite (*Prosopis* spp.)
Needlegrasses (*Stipa* spp.)
Ponderosa pine (*Pinus ponderosa*)
Prairie brome (*Bromus catharticus*)
Pubescent wheatgrass (*Agropyron trichophorum*)
Rose clover (*Medicago hirtum*)
Sagebrush (*Artemisia* spp.)
Scrub oak (*Quercus dumosa*)
Shinnery oak (*Quercus* spp.)
Smilo (*Oryzopsis miliacea*)
Smooth brome (*Bromus inermis*)
Wedgeleaf ceanothus (*Ceanothus cuneatus*)
Yerba santa (*Eriodictyon californica*).

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Commodity Report

Forestry and Forest Industries in Russia's Sixth Five Year Plan

The directives of the twentieth congress of the Communist Party of the Soviet Union for the development of the national economy of the U.S.S.R. during the quinquennium 1956-1960 throw a good deal of light on the evolution of the forest economy and forest industries planned for the coming years.[1]

Two features of the plan are of particular interest: the shift away from timber to other commodities as a structural material; and the extent to which increased productivity, more effective use of capacity and more rational use of raw materials are relied upon in achieving the considerable increases in output called for by the plan.

By 1960 it is planned to raise industrial production by 65 percent as compared with 1955. Output of production goods is to rise by 70 percent, that of consumption goods by 60 percent: thus the primacy of production goods is maintained, though the increase in the flow of consumption goods is greater than that envisaged in any of the preceding plans. It is also planned to build at state expense about 205 million square meters of housing during the quinquennium, i.e., nearly twice the amount provided for in the fifth Five Year Plan.

Against these ambitious targets for industrial production, and an equally ambitious target for construction, the increase provided for in the flow of primary forest products seems relatively modest. Removals of industrial wood are to rise from 197 to 264 million cubic meters (or by 34 percent) between 1955 and 1960, and sawnwood output from 58 to 80 million cubic meters (or by 38 percent). This discrepancy between the course of sawnwood consumption and the development of industrial production and building activity parallels the similar movements which have taken place and are continuing in Western Europe and North America.

How are the housing and other constructional targets to be achieved? In the first place, by a very rapid increase in the output of cement and its products. Cement production, which amounted to 22.5 million tons in 1955, is to rise to 55 million tons (or by 145 percent) by 1960.

A principal objective in the building materials industry, states the plan, is the large-scale production of materials and manufacturing goods permitting extensive use of prefabricated elements, e.g., prefabricated articles in reinforced concrete, wall panels, partitioning elements, sanitary equipment, and cladding materials. Thus, for example, the production of framing and other prefabricated elements in concrete is to increase sixfold, while output of lime and bitumen board is to double. The general plan for the building material industry is set out in more detail in the paragraphs dealing with the targets for the several Soviet Republics; elsewhere in the plan, an increased output of wagons for transporting cement is provided for. By 1960, the consumption in building and civil engineering of prefabricated elements in reinforced concrete will rise to 28 million cubic meters, including 7 million cubic meters of prestressed concrete. This calls for a rapid mechanization of building methods, a greatly expanded machinery park for the building industry, the establishment of repair shops, and a concentration of enterprises. There is great emphasis on achieving the maximum economies in the use of wood and metal, and special attention is paid to the development of the building industry in the eastern regions of the Russian Soviet Federated Socialist Republic (R.S.F.S.R.).

The mechanization of building operations will be accompanied by rationalization and automation of the building materials industry. In the special chapter devoted to the mechanization and automation of industrial operations, it is laid down that the extraction of non-metalliferous materials will be completely mechanized, that extensive automation will be introduced in the cement industry, and chain production methods instituted on a large scale in the asbestos cement and similar industries. The output of asbestos cement, incidentally, is planned to more than double, reaching 3,050 million standard sheets in 1960.

The replacement of wood by other materials is not restricted to building. The plan for the coal industry provides for reduced wood consumption in mines and a considerable increase in the share of metals and reinforced concrete as mine supports. Similarly, the chapter dealing with transport calls for all necessary measures to prolong the life of wooden sleepers and to make more extensive use of concrete sleepers.

However, in spite of replacement and wood economies, a considerable expansion in the forest industries

[1] A report on plywood, in the normal series of Commodity Reports included in *Unasylva*, will appear in Vol. 10, No. 3. This provisional analysis of the U.S.S.R. sixth Five Year Plan has been written by an FAO staff member.

will be required to achieve the targets set out. To this end, fellings are to be increased and sawmills constructed in the heavily wooded regions. Between 1956 and 1960, additional sawmill capacity amounting to 16.5 million cubic meters is to be brought into service. Further efforts are to be made to reduce seasonality in forest exploitation operations, thus building up a settled all the year round labor force. There is plainly great concern about the amount of labor absorbed by all operations in the forestry and forest products sectors — in felling, hauling and conversion — and the plan aims to mechanize completely the principal felling operations and many of the auxiliary operations. Thus further efforts are to be made to transfer some of the conversion operations from the scene of felling to loading stations on the haulage routes. This will require an increased supply of tractors and high capacity lorries, while permanent sources of energy for the forest industry will be created, notably electric plants operating on wood waste.

In the new plan, special attention is paid to the development of specialization and inter-industry cooperation. Thus no less than 15 sawmills and specialized wood processing enterprises, with a total annual capacity of 4.5 million cubic meters, are to be built for the fabrication of semi-finished goods for the automobile, agricultural machinery, wagon and furniture industries.

The plan, of course, makes no mention of the development of the Soviet Union's timber export potential. Plainly the overwhelming proportion of forest output will, as today, be directed towards satisfying domestic needs. Currently, Soviet sawnwood exports represent only 3 to 4 percent of total production, even though she has now become one of Western Europe's four main suppliers. Yet there are certain aspects of the plan which suggest that more sawnwood could be exported, assuming favorable conditions of trade exist. These indications lie in the details concerning the development of transport and communications.

The volume of goods traffic by rail (in kilometric tons) is planned to rise by 42 percent. To this end, 225,000 new goods wagons will be brought into service, a further 8,100 kilometers of track will be electrified, 6,600 kilometers of existing track will be doubled, and 6,500 kilometers of new track will be built. There is special emphasis on raising the traffic capacity of the Ural region and Siberia, and of the lines connecting the Ural with the Volga, central and eastern regions. Certain of the new lines planned are specifically aimed at facilitating the development of new or existing forest industries, as, for example, those connecting Atchinsk and Abalakovo (in the upper Yenisei area, near Krasnoyarsk), and Mikun and Koslan (on the upper Mezen). New rail construction will also continue in the Karelo-Finnish Republic, where industrial wood removals are planned to rise by 50 percent and wood conversion by 80 percent.

On inland waterways, the volume of goods traffic is to rise by 80 percent. The river and canal fleets will be greatly expanded and inland port facil[illegible] including those on the great Siberian rivers, enlarged and modernized. Thus, in the course of the quinquennium, the Ministry of River and Canal Transport is scheduled to receive tugs and self-propelled boats aggregating 720,000 horsepower and barges of [illegible] tonnage 2,245,000 tons.

The volume of sea traffic is to be more than doubl[illegible] The maritime cargo fleet will be augmented by 1,140,000 tons (excluding tankers). Bigger and faster diesel-engined cargo boats (including those for the transport of timber) will ensure that an increased proportion of the U.S.S.R.'s sea trade is carried in Soviet ships. Among the maritime ports singled out for special attention in expanding facilities and mechanization, are Leningrad and Murmansk, Vladivostock Vanino (a recently established port near Soviet Harbor on the Gulf of Tartary), and Petropavlovsk in Kamchatka. The construction of the port of Nakhodka, on the sea of Japan, is to be completed and work continued on the development of the new port of Ozernovski, on the western shore of Kamchatka. Nakhodka and Slavianka will become important ship repair centers in the Far East.

These developments in transport and communications accord with those aspects of the plan which call for increasing integration of the Soviet economy; they are also consonant with a considerably expanded external trade. Notable is the development of facilities in the Far Eastern territories of the R.S.F.S.R. In fact, a continuation of the eastward shift of the economic center of gravity of the U.S.S.R. is implicit in the targets set — industrial, agricultural and in transport — for the several regions of the R.S.F.S.R. and the various Republics.

As in the previous Five Year Plan, paper production is planned to rise by 46 percent in the course of the next quinquennium. This figure, however, excludes paperboard, of which output was about 500 thousand tons in 1955, and for which a 180 percent increase is scheduled. Thus, if the targets set are achieved, Soviet paper and board production will increase as follows:

Year	Paper	Board	Total
	..... *in thousand metric tons*		
1955	1 830	500	2 330
1960	2 720	1 400	4 120

This expansion is much greater than that envisaged in industrial wood fellings, and the text of the plan confirms that, in addition to making greater use of broadleaved species, the pulp mills will convert ever greater quantities of both sawmill and forest waste, as well as non-wood materials, notably reeds. The plan provides for increased production of fibreboard and chipboard, both of which are so far manufactured on a relatively small scale; both these wood products are destined to play an increasingly important role

in the Soviet building industry. An interesting figure in this chapter of the plan is the expansion envisaged in the production of alcohol — no less than 180 percent.

The pattern of paper expansion differs somewhat from that in Europe and North America. Against an increase in total paper output of 46 percent, production of newsprint and printing paper are to rise by 51 and 60 percent respectively. This concords with the 50 percent rise foreshadowed for the newspaper, periodical and book publishing industry. The fact that currently all new book issues, whether fiction or technical, are invariably oversubscribed testifies to the need for a considerable rise in the output of printing and writing papers. Since the production of sundry industrial papers is also to rise sharply, it is evident that a relatively smaller growth in the production of packing and wrapping papers (though not of board) is envisaged. Clearly, not all the factors which have led to the astonishing growth of kraft wrappings in the west are present in the Soviet Union: this may account for the somewhat different pattern of paper growth.

Associated with the plans for the pulp industry is the remarkable growth envisaged in the production of artificial fibres: this is to increase four-fold during the quinquennium, reaching 330,000 tons in 1960. This is in sharp contrast with the plan for natural fibres (cotton, increased by 23 percent; wool, increased by 45 percent), and bears witness to the faith of the Soviet planners in the future of man-made fibres. The share of non-cellulosic fibres is to rise from 9 to 44 thousand tons, while, by 1960, 5,000 tons of glass fibre will be produced.

Full geographical details of the planned pulp and paper expansion are not included in the plan, but the text makes special reference to the Karelo-Finnish Republic and the Eastern regions of the R.S.F.S.R. In the former, the existing pulp and paper plants at Kondopoga and Segueja are to be expanded, and a new board mill built (as well as an integrated sawmill, wood-processing plant and furniture factory at Novo-Kemskaia). Five new pulp and paper mills and seven rayon factories are to be built in the Eastern regions.

Throughout the plan there is great emphasis on the need to raise labor productivity, make effective use of available capacity, streamline production processes and eliminate waste. Thus, of the planned increases in output of paper and board, it is aimed to realize, by these means, no less than 56 percent and 12 percent respectively.

The forests are not neglected, but in the new plan the emphasis appears to have shifted slightly away from grandiose plans to transform nature towards a greater concentration on the effective management of existing forests. Improvement work is to be carried out over 190 million hectares, 3 million hectares are to be planted with commercially valuable fast-growing species, work contributing to natural regeneration is to be carried out over 3.8 million hectares. The fight against soil erosion and desert encroachment continues: 370,000 hectares are to be planted in gullies and on sandy soils; 460,000 hectares of shelterbelts are to be planted on collective farm lands.

The U.S.S.R. has a forest area per inhabitant well over twice the world average. Within its borders is to be found one-third of the growing stock in all the world's forests currently being exploited. The extracts from the sixth Five Year Plan quoted in the preceding paragraphs show that these forests, and the industries based upon them, will have an important part to play in the development of the Soviet economy in the coming years.

J. C. W.

Latin-American Forestry Commission

The Fifth Session of the Latin-American Forestry Commission was held at Caracas, Venezuela, from 4 to 11 October 1955. It was followed by a study-tour which has already been reported in Unasylva (Vol. 9, No. 4, page 201).

The following member countries were represented: Argentina, Bolivia, Colombia, Cuba, Dominican Republic, Ecuador, El Salvador, France, Guatemala, Honduras, Mexico, Netherlands, Nicaragua, Paraguay, Peru, United Kingdom, United States of America and Venezuela. Observers were present on behalf of the Holy See, the Organization of American States (OAS), World Meteorological Organization (WMO), International Union for the Protection of Nature, and the United States International Co-operation Administration (ICA). I.T. Haig represented the Director-General of FAO.

After the Chairman of the Commission, Mr. Lucas A. Tortorelli (Argentina) had warmly thanked the Venezuelan authorities for having afforded the facilities for holding the meetings under such favorable circumstances, the Minister of Agriculture and Livestock of Venezuela, Dr. Armando Tamayo Suárez, declared the Session open. The opening meeting was also attended by Dr. Aureliano Otáñez, the Minister of Foreign Affairs, and Dr. José Loreto Arismendi, the Minister of Education. All three Ministers were elected Honorary Vice-Chairmen of the Session while the Commission elected as Honorary Chairman, His Excellency General Marcos Pérez Jiménez, President of the Republic of Venezuela.

It elected as Chairman of the Commission for the next term of office, Dr. Antonio Uzcátegui (Venezuela) and Vice-Chairman for the same period, Mr. Riccardo Lavagnino G. (Guatemala). Mr. Manuel A. Gonzáles Vale (Venezuela) was appointed Rapporteur of the Fifth Session.

The Commission set up three *ad hoc* sub-commissions to deal with various items of the agenda, and the officers appointed to them were:

Sub-Commission I

Chairman: Mr. Ernesto Noriega C. (Peru)

Rapporteur: Mr. Hernando de Irmay (Bolivia)

Secretary: Mr. Angel Francisco Luján (Venezuela)

Sub-Commission II

Chairman: Mr. Tobías Lasser (Venezuela)

Rapporteur: Mr. Frank H. Wadsworth (United States)

Secretary: Mr. Simón Alvárez (Venezuela)

Sub-Commission III

Chairman: Mr. Jorge N.F. Carmelich (Argentina)

Rapporteur: Mr. Riccardo Lavagnino G. (Guatemala)

Secretary: Mr. Gustavo Pinto C. (Venezuela)

Forest policy

The Commission gave careful study to the national progress reports on forest policy submitted by Member Governments, and after interesting discussions on a number of policy issues, resolved to set up a working party to frame a long-term program for forestry development in Latin America, suggesting to the Director-General of FAO that he request the help of the Economic Commission for Latin America (ECLA) and any other appropriate organizations he deemed advisable, in working out such a program.

Finally, at the instance of the delegate of El Salvador, the Commission discussed the desirability of co-operation between countries in supplying their requirements for forestry technicians, and the question of co-ordinating the work of the governments of various countries in the matter of vocational training, with a view to making the best use of technicians being graduated from existing schools. It suggested that such co-ordination could best be effected through FAO, and decided to refer the matter to FAO for study, with the recommendation that it be further explored by the above Working Party.

The Commission adopted a revised plan for the Latin-American Forest Research and Training Institute, which was subsequently approved by the FAO Conference. The plan entails the creation of a regional Committee on Research. Owing especially to the generous co-operation of the Government of Venezuela, the establishment of the Institute now seems assured.

Other items

The Commission recommended an early exchange among countries of the region of material relating to forest terminologies, and advised the Chairman of the Commission to include an item on Forest Terminology on the agenda of the Sixth Session. The Commission took note of the fact that various member countries in the region had already done a great deal of work on forest terminology. The Spanish-English Glossary of Forestry Terms mentioned in the report of the Fourth Session as being prepared in Puerto Rico, was ready and would soon be distributed.

The Commission decided to set up a Working Party on Forest Planting and recommended to the Governments of Latin-American countries:

(*a*) speeding-up of afforestation studies and planning, to determine which areas were ecologically and economically most suitable, so as to avoid dispersal of effort and possible financial failures of planters who are now, or may in the future, be interested in such work;

(*b*) study of appropriate governmental measures for promoting forest planting by supplying planting stock, technical advice, and government credit facilities.

Other topics dealt with by the Commission were forest management in relation to developing the pulp and paper industry, grading of timber, forest protection from fire and pests, and forest climatology.

The Commission noted with great appreciation the invitation of the Delegate of Guatemala, tendered on behalf of his Government, to hold its next session in Guatemala City. In accordance with the Rules of Procedure, the Director-General of FAO and the Chairman of the Commission would finally decide the date and place of the next session.

Seminar for Forest Research Specialists

In accordance with desires expressed by the Asia-Pacific Forestry Commission, arrangements were made by FAO with the Government of India as host, to hold a Seminar for Forest Research Workers of the region. Dr. K.R. Nair, statistician for the Forest Research Institute, Indian Forest Service, as representative of the Government of India, and Mr. J.G. Osborne, statistician for the United States Forest Service as FAO Representative, were appointed as Co-directors for the seminar. Mr. L.K. Strand, Professor of Forestry and Statistical Consultant from Norway, was appointed as Monitor. The seminar was held at the Forest Research Institute at Dehra Dun, from 12 October to 10 December 1955. It was planned to deal primarily with the application of statistical methods in forest research, particularly in the field of silviculture.

The objective of the seminar was to make a thorough and systematic coverage of the design of experiments and the statistical theories basic to the analysis, interpretation, and presentation of results of experiments and sampling investigations. Treatment of the subject matter was from the point of view of the practicing forest research worker and the methods investigated were chosen specifically to meet the day-to-day needs of his work.

Forest research workers in this region have long been acutely aware of the place of statistical methods in sound experimentation. They have followed the work of their colleagues in agricultural research in the application of modern experimental designs but, at the same time, have recognized the intrinsic differences between agricultural and forest experimentation that make indiscriminate adoption of the experimental designs used in agriculture unwise.

The forest research worker recognized that in order to go forward confidently in his application of statistical methods to his work he must, himself, become proficient in the fundamental principles upon which efficient and sound experimental designs are based. He could not depend upon either the agricultural statistician or the mathematical statistician to hand him designs tailored to meet his needs. The experimental material with which the forester works normally is much more variable than that with which the agricultural statistician works and therefore presents problems of experimental control not met by the latter. The forester must have a sound foundation in both statistical theory and forestry in order to develop his own experimental designs or to avail himself of the assistance of the mathematical statistician. It was for these reasons that the course of study adopted by the Co-directors was a fundamental one. Due to the remote locations of many of the participants, it was felt that they must be made largely self-reliant. At the minimum they should be able to resolve the bulk of their statistical problems from their own knowledge, and design experiments that can be analyzed directly and unambiguously. They must be able to recognize situations in which these requirements cannot be met and to avail themselves of the purely mathematical assistance of professional statisticians.

In all, nine countries were represented by participants in the seminar: Burma, Ceylon, Indonesia, Japan and Malaya each nominated two students; Pakistan, New Guinea (Australia) and New Guinea (Netherlands) one each; and India supplied five.

In the invitation, it was pointed out that maximum benefit would be obtained from the seminar if the participants had had experience in forest research and some grounding in mathematics. It was emphasized also that it was clearly desirable that only those participants should be considered who, on their return from the seminar, would be engaged in forest research.

Evidence of the sincerity of interest of the participating countries is apparent in the high caliber and rank of the participants selected. Almost without exception the men are directing research or performing research at a responsible level.

This was important to the success of the seminar since, with representation at a high level the participants upon returning to their home countries will be in a position to influence the research programs and to foster immediate adoption of sounder and more efficient techniques.

Forest Working Techniques and Training of Forest Workers

The technical work of FAO has two main aims: first, the quantitative increase in output of food and agricultural products — the growing and harvesting of two blades of grass where only one has grown before; secondly, the raising of the standard of living of the world's population. These aims are complementary and interdependent. An improvement in living standards can be achieved only by increased production accompanied by increased wages. Increased production with increased wages is only possible on the basis of a rise in productivity.

Productivity has two aspects — human and material. It is generally agreed that performance in any sphere can be improved by training, in other words there are "best methods" whereby maximum results may be attained for a given energy expenditure. Within the limits imposed by physiological factors, therefore, improved techniques and vocational training can raise production standards. The question of working techniques is, however, closely bound up with the second aspect of productivity — that of tools and machinery. The utilization of suitably designed tools which facilitate the work and contribute to the rationalization of working methods, and of machinery to take the place of human muscle power can multiply output many times over.

The rationalization and mechanization of industry is already a familiar story, dating from the nineteenth century. But that of agriculture and forestry has, in general, been lagging in both "developed" and "underdeveloped" countries. Thus, even in Europe, the mechanization of forest work has got under way in some countries only during the last ten years or so, and there exist many regions where powered equipment for such heavy and arduous work as felling and logging is the exception rather than the rule.

In view of the difficulties faced by the European forest industry, where irrational and old-fashioned methods of exploitation have kept production costs high and output low, and where existing wages and conditions have provided but little incentive for a largely unskilled and constantly diminishing labor force, FAO set up in 1952, as a subsidiary body of the European Forestry Commission, a Pilot Committee on Logging Techniques and Training of Forest Workers. Its terms of reference were to foster international collaboration in the field of felling, logging and timber

transport, in order to support national efforts aimed at increasing productivity, including output of labor, reduction of waste, prevention of accidents, and the improvement in the standard of living of forest workers. The program of work of the Pilot Committee, which comprised experts from eight European countries, covered working techniques and performance, mechanization and vocational training (in co-operation with the International Labour Organisation).

This work is now being continued on an all-European basis by the Joint Committee on Forest Working Techniques and Training of Forest Workers, set up in 1954 by the European Forestry Commission and the Timber Committee of the Economic Commission for Europe. The first session of this committee, held in December 1955, on the invitation of the French Government, at Nogent-sur-Marne, near Paris, was attended by sixty-five delegates from nineteen European countries, the United States and Soviet Russia, and by representatives of various international and non-governmental organizations.

The Committee's program of work covers: working techniques, mechanization, mountain logging, forest workers' training and safety, and terminology. This program is being implemented through specialized study groups, and individual experts and research stations are entrusted with the carrying out of various technical studies.

Working methods and techniques

With a view to increasing productivity in forest work, the Joint Committee is studying the question of working techniques and has set up a study group to deal with this problem. The considerable variations in performance which exist between different countries, and even between different regions in the same country, call for research in this field. The comparison of working techniques, the scientific study of working processes and the assessment of "best methods" in such operations as felling and barking are occupying the attention of various experts.

An important contribution towards the popularization of rationalized working methods in Europe has been the holding of international training courses for forestry timekeepers. These courses, organized by the Federal Institute for Forest Research, Zurich, for the Pilot Committee and for the Joint Committee in 1953 and 1954, have been attended by about forty students from nine European countries. A further course is planned for 1956 in the same center.

Mechanization

The program of the Joint Committee in the field of mechanization is being implemented through two study groups on the Testing of Forest Machinery and on the Application of Machinery to Forest Work. Arising out of the work of these study groups, a recently published report on tractor requirements in European forestry gives a detailed specification of the characteristics of tractors and tractor equipment to be used in the forest, with a view to providing a guide for tractor users and manufacturers; a system for the costing of powered vehicles and machines has been worked out and will shortly be published; a system of standard tests for forest tractors, which has been proposed by the Study Group on the Testing of Forest Machinery, is to be finalized by a special *ad hoc* working party of experts from participating countries, which will subsequently sponsor trials at national tractor testing stations.

These two study groups are likewise concerned with, for instance, investigations on power saws, mechanical and chemical barking, loading, bundling of small timber and skidding. Studies on these questions are in preparation.

Since in many European countries the degree of mechanization in forest work is still small, the Joint Committee is an important forum for the exchange of information, in particular with regard to new techniques such as full-tree logging and chemical barking which are first adopted in the more advanced countries.

Mountain logging

Logging under specifically mountain conditions has, in the past, been developed to any significant extent in only a few mountainous countries such as Austria and Switzerland, which have perfected for this work a completely specialized set of techniques such as the use of aerial cableways, slideways and chutes. In other countries, rich in forests, this type of exploitation has so far been of marginal importance. But these countries are now interested in studying the economics of mountain logging with a view to expansion in this sector. Therefore, through its Study Group on the Handling and Transport of Timber in Mountainous Regions, the Joint Committee is conducting investigations on aerial cableways, ground line haulage, construction of forest roads, slides and slipways and the use of power saws under mountain conditions.

Forest workers' training and safety

The Joint Committee has co-operated with the International Labour Organisation (ILO) in these fields. A report on training facilities in Europe, drawn up by the ILO, brings out the relationship between measures taken to improve the professional quality of forest workers and the social and economic conditions prevailing in this occupation. The report also emphasizes the close dependence of vocational training schemes on the work of research institutes, which aim to improve the workers' productivity and raise safety standards. A survey on accidents and preventive measures in forest work is likewise being carried out by the ILO for the Joint Committee.

Much attention has been devoted to the training of teaching personnel, since this is regarded as one of the key problems in the raising of vocational training standards. Thus, the Joint Committee is organizing the exchange, between participating countries, of information on training courses, and the exchange and co-ordination of teaching materials, such as textbooks, pamphlets, slides and films. The ILO has co-operated in sponsoring scholarships for study tours for forestry instructors in various European countries. In 1955, 21 such scholarships were allocated and the scheme is expected to continue in 1956.

Terminology

The standardization of terminology constitutes a serious problem in all branches of forestry. This is particularly acute in regard to forest work science, due to its comparatively recent and rapid development. New concepts and terms are constantly appearing in all languages and the problem of standardization has so far only been tackled in a piecemeal or *ad hoc* manner. The Joint Committee has therefore set up a special study group on this question which is charged with the compilation of a multilingual glossary of forest work science, the languages being English, French, Russian, German and Swedish.

Field study

Delegates to the First Session of the Joint Committee took part in a study trip organized by the French Government from 19 to 22 December, 1955. Visits were made along the route Paris - Nancy - Abreschwiller - Saverne, where manual and mechanized felling and haulage in coppice and high forest, under lowland and mountainous conditions, were inspected, and demonstrations of hauling and cutting machinery attended. An inspection was also made of the forest and workshops of the *Ecole de Bûcherons* at Saverne.

FAO ECE Joint Working Party on Forestry and Forest Products Statistics

This working party held a first session at Geneva in January 1956 when discussions were concentrated mainly on a minimum long-term program for forestry and forest products statistics and on the world forest inventory to be undertaken in 1958.

Minimum long-term program

The minimum long-term program is intended to provide an indication of the range of statistics which all countries should seek to develop progressively in the course of the coming years, with the object of furnishing themselves with all the basic data essential to the prosecution of sound forest and forest industry policies, whether in the public or private sector. Obviously there are many advantages to having national statistics internationally comparable.

Agreement was reached on a skeleton of a minimum program comprising 14 chapters (and the principal categories of information within each chapter) under the following four main sections: forest statistics; statistics of forest industries; labor statistics; and forest products statistics. Details remain to be worked out at a subsequent session, but it was agreed that forest industry statistics should relate only to primary forest industries, e.g., industries using unprocessed wood as raw material and turning out commodities largely used as raw materials for secondary manufacture.

On the question of priorities, the inclusion of any chapter within the minimum program implied that, in that particular category, statistics were considered important to national needs. In singling out certain chapters for the immediate attention of all countries, the Working Party simply wished to draw attention to particular chapters that were either of first importance from the standpoint of an international program, or lent themselves more readily to immediate implementation, or both. In this sense it was agreed that those statistics should receive first priority which deal with forest area, growing stock, growth, domestic roundwood supply, output of processed wood, external trade of all forest products and prices.

It was desirable that concepts and definitions in the field of forestry and timber statistics should not conflict with general statistical standards. Close co-operation between forestry and timber statisticians and central statistical offices or other general statistical services was required to ensure that, in drafting statistical programs, conceptual problems of duplication and overlapping could be satisfactorily resolved.

World forest inventory of 1958

The statistical forms relating to the 1958 world forest inventory, in so far as they concerned Europe and North America, were thoroughly discussed. The questionnaire adopted for the 1953 inventory had on the whole proved satisfactory, admitting the fact that it is difficult to arrive at definitions that are universally acceptable. The information to be sought in the new enquiry should consist of a limited range of salient facts deemed essential to the formulation of national forest policies.

Other statistical requirements

The Working Party discussed the desirability and practicability of formulating medium-term forward estimates of fellings. It would be mutually advantageous if country felling forecasts were to be available internationally. All countries that were members of the European Forestry Commission or Economic Committee for Europe (ECE) Timber Committee should be requested to furnish forward estimates of annual fellings around the years 1960 and 1965, on the basis or bases appropriate to or practicable for the individual countries.

It was decided to abandon the current FAO questionnaire form dealing with fellings, removals and utilization of roundwood, but the possibility of obtaining utilization data through special periodic enquiries should be further explored. A new annual form should deal with removals, broken down into removals coming from the forest proper and from outside the forest area.

The Working Party also considered the question of statistics on investments in forestry which, although of considerable interest, present special difficulties and are liable to misinterpretation. It was decided that, in the first instance, attention should be limited to investments in afforestation and plantations outside the forest.

As regards pulpwood statistics, existing statistics failed to reveal the rise in the utilization of materials other than coniferous woods. Data on this point were necessary for a proper appraisal of the pulpwood market, and specific proposals regarding definitions in both the Standard International Trade Classification and national trade accounts would be made at the next session of the Working Party.

Participation

This first session was held under the Chairmanship of Mr. J. Keller (Switzerland). The following countries nominated representatives: Austria, Belgium, Germany, Finland, France, Italy, Netherlands, Norway, Sweden, Switzerland, United Kingdom, United States and the U.S.S.R. A representative of the Organization for European Economic Co-operation (OEEC) also participated. The Working Party decided to hold a second session in Geneva from 12-17 November 1956 when it would discuss statistics relating to manpower forest fires, prices, end-use, and investments.

Equipment Section

Mechanized Equipment for Afforestation Work in France[1]

A pamphlet has been widely distributed to forest owners in France explaining the advantages of the use of mechanized equipment in tree planting operations.

In the first place, the use of machines ensures good tillage of the soil and consequently a high percentage of success with the planted stock. Delay in the trees putting on growth which, at least for quick-growing species, can appreciably lower the return on the investment, is thus avoided. At the same time, it permits economy in outlay on nursery stock and seeds, the cost of which can be high for relatively scarce species or specially selected plants.

On some sites, where the climatic and soil conditions are particularly unfavorable, mechanization seems often to be the only method of guaranteeing success in afforestation.

Mechanization is also often a means of reducing costs. As against manual labor it has advantages in regard to soil preparation and also in the actual planting operations: quicker setting-out techniques; use of smaller (or younger) planting stock owing to a more thorough clearing of competing vegetation, and better conditions for initial growth.

The period suitable for carrying out planting work in both spring and autumn is always short. By finishing the work quicker with machines, the operator may keep within the optimum period and so ensure a higher percentage survival of plants.

Lastly, mechanization affords psychological and social advantages. The landowner considers that it offers a more spectacular and 'modern' work effort. The operator feels he is doing more up-to-date work; young and capable workers are more easily attracted to forestry, and because of the increased output better salaries can be paid.

Special working conditions

Save in exceptional cases (nurseries or the planting of land where farming has been recently abandoned), forestry equipment has to be employed both in and outside the forest under conditions different from those under which farm machinery proper is used The latter can be utilized for forestry only in certain circumstances.

Machine manufacturers are thus faced with a new problem and the correct solution can come only from collaboration between them and the users, since each knows only one side of the question.

The main feature of work connected with tree planting is its diversity. There are always visible or hidden obstructions in the ground, and it is in relation to this peculiarity that the nature of the machines for planting has to be considered.

A first solution would be to have sturdy machines sufficiently high-powered to overcome practically all obstructions. Experience shows that in many cases this leads to the use of an engine power of over 100 horsepower and very heavy machines (10 to 20 tons) with a very high amortization, which in consequence, need to be intensively utilized, a practice that, with a few exceptions, is not compatible with the location and the lie of the land to be planted in Metropolitan France. To this must be added the high cost of moving such equipment and accessories, fuel and especially breakdown equipment, made more difficult on account of the weight. This is a greater drawback than fuel consumption which is limited in its effect; in fact, more often than not, high-powered equipment operates at a low working speed.

Heavy machines, therefore, are only worthwhile for large forestry enterprises or when the cost factor is of minor importance: for instance, when afforestation for soil rehabilitation and protection must necessarily be carried out even under difficult conditions, for the public welfare. Further, such machines should be in fairly general use so that they are readily available on the market and this does not appear to be the case in Metropolitan France.

Features of forestry equipment

It is usually better, therefore, to aim at the use of less powerful equipment. The requirements that equipment for planting work should meet are:

1. Sturdiness.
2. Extra reserve of power so as not to be constantly held up by small obstructions.
3. Means of avoiding visible obstructions (intermittent working, power lift, elevating device).
4. A system of overcoming obstructions, hidden or impossible to avoid. The machine must be reversible and retractable. In the absence of a mounted or semi-mounted tool, the (trailing) implement will be hitched to a rigid drawbar. In every case, a lift device that does not call for forward movement must be provided (winch on trailed implements, automatic lift device for semi-mounted or mounted implements).
5. The possibility of offering satisfactory working conditions to the operators from the standpoint of both safety and work effort.
6. Equipment that is easily kept in good repair (especially the engine). Even more so than in farming, a well organized repairs and spare parts service is of primary importance. The equipment is often used under trying conditions and consequently often breaks down. Because there is not much of the equipment in general use, replacements of parts are not easily obtainable.

The user of tree-planting equipment must always bear in mind that, unlike the farmer, he does not have to seek after a perfect and unbroken piece of work. If a few dozen yards are passed over no serious inconvenience will be caused. In the same way, since there are always liable to be hidden obstructions, it is often more economical to do the work in several stages. He should be content, at first, with a superficial working that will allow him to detect the operating difficulties. In trying to do a finished job all at once, the operator runs the risk of frequent hold-ups or breaking his machines.

[1] Contributed by the Forest Research and Experimental Station, Direction generale des eaux et forêts, France.

Power Source

Self-propelled equipment

These are the specialized machines, the engines and transmission gear of which are designed for the particular work to be carried out. Their disadvantage is that the amortization of the initial cost devolves on a single machine. Even in the case of multi-purpose equipment it is usual to employ low-powered units, because with medium-and high-powered units, the price and weight of the motive power soon cease to be acceptable.

Tractors

These can be used in two different ways:

(*a*) solely for traction for front-mounted or pushed implements;

(*b*) for both traction and driving force to operate the working parts of the equipment through a power take-off.

In the second case, there is a disadvantage that is not found in farming. The power take-off of a tractor takes up only part of the total power. Whenever an obstruction is met with, as is very often the case in forestry work, the tractor can always move forward but the total force available at the power take-off is already absorbed, and so there is a risk of the equipment being damaged. In addition, transmission from the power take-off to the implement is usually effected through the cardan shafts which are rather fragile; they bear the brunt of the jolting of the machine in operation, and are not always strong enough to withstand the effect.

Tractors can be divided schematically into the following groups:

1. 20-30 horsepower, often too light for afforestation work;
2. 40-50 horsepower, medium-sized tractors sufficiently common to be easily obtainable, and which appear to be the desirable type;
3. 70-80 horsepower, heavy models that sometimes have to be used, but which have the disadvantage of being far less common than the above size.
4. 100 horsepower and over, very heavy tractors that are seldom available.

Crawler-type tractors. These have the advantage of better grip on heavy ground and a shorter turning radius, but the drawback of being less in general use and difficult to convey from one site to another. In addition, the tracks are weak parts. Their amortization is poor because of their high cost and rapid wear and tear. But crawler tractors are generally preferred for difficult operations on sloping land, when the use of broad tracks offers definite advantage.

Rubber-tyred tractors. These are more easily transported by road and are much more common. Their disadvantages when used on soft ground are more or less offset by the use of grip devices which are becoming popular (water-weighting, retractable flanges, chains and detachable half-tracks, rotapède tracks).

Lift device. This is an improvement that instead of being almost a luxury, as in farming, is often in planting work a necessity. It is essential for mounted implements that are generally much more easy to use than trailing implements. The hydraulic lift device is more rapid and more flexible than the winch, but the latter has the advantage of being sturdier.

Equipment Planting Operations

Forest nurseries

A check list of useful equipment is given at the end of this article. It does not claim to be final but merely summarizes present practices.

Notes on particular items of equipment

Power cultivators. There is a wide range for various operations, particularly tillage.[1] These machines have the great advantage of expediting soil preparation in nurseries, all the more to be appreciated as the period suitable for such work is usually short.

Except in the case of very large nurseries, the tendency will be to look for power cultivators which, by their coupling system and range of adaptable implements, can be put to many uses, in order to allow of satisfactory amortization. If the power cultivator is to be trailer-hitched, it has to be equipped with rubber tyres.

Extremely light soils require only 5 horsepower, while average soils call for 8 to 9 horsepower and heavier soils for 10 to 12 horsepower.

Rotary hoes. Undoubtedly the most useful tool in a forest tree nursery, and far superior as regards quality of work to manual labor, is the horizontal-shaft rotary hoe, which pulverizes the soil surface to the extent necessary for the development of good root systems. There are two types:

(*a*) self-propelled hoes designed for this work only;

(*b*) rotary hoes which can be fitted to power cultivators.

Clearing of surface vegetation

Herbaceous vegetation

Cutter bar front-mounted power-driven mowers. These self-propelled machines are very useful for preparatory work or tending. The power required is about 5 horsepower, and it has been found that in many cases the width of the cutter bar should not exceed 1 meter for easy handling. Sometimes metal wheels are more suitable for working in the forest since rubber tyres easily puncture.

Front-mounted cutter bars attachable to power cultivators. This combination achieved by some manufacturers has the advantage of providing a single machine for several uses, but the drawback, for large or medium size cultivators, of using more power than is needed for cutting. Forestry requirements make it difficult or impossible to use side-delivery cutter bars.

Woody vegetation

Trailed brush cutters. These consist of wheels or rollers equipped with knives which, if they are sufficiently heavy (the effect is obtained by their weight) and speedy, break up the vegetation in their path. The brush-cutter used in the Landes Region (*Débrousailleur landais*) is an example. They have the advantage of being sturdy and of lightly cultivating the soil, but can operate only where a tractor has been able to pass (Figure 1).

Vertical-shaft brush cutters. A horizontal blade is driven round a vertical shaft by the power take-off of a tractor. The drawback mentioned above (need for preliminary passage of tractor) also applies here (Figure 2).

Front-mounted scrub-clearing equipment. These include:

(*a*) power brush cutters (self-propelled machines which remove woody vegetation with a front-mounted disc);

(*b*) implements front-mounted on the frame of a tractor and operated by the latter's power take-off;

(*c*) portable equipment including a front-mounted implement and a small motor.

In the main, front-mounting allows operation among any type of vegetation provided that the equipment is sturdy enough, but this system necessitates protective devices for the

[1] Not deep plowing, which is seldom required and is done with regular farm machinery.

FIGURE 1. MARDEN DUPLEX (DÉBROUSSAILLEUR): *Marden Manufacturing Co. Auburndale, Florida, U.S.A.*

FIGURE 2. "GYRO-84" BRUSH CUTTER: *Servis Equipment Company, 1000 Singleton Boulevard, Dallas, Texas, U.S.A.*

operators and the removal of the cut vegetation. Further, its use on stony or rocky ground sometimes raises difficult problems.

Surface soil cultivation

Tillage implements remove plant growth when not too dense.

Moldboard plows

These have the advantage of turning over the soil and bringing small obstructions (stones) to the surface (Figure 3). They ensure an efficient cleaning or scalping, that is, removal of the ground cover to eliminate competition. However, there is the risk of the point of the plowshare penetrating obstructions and becoming jammed. This drawback can be lessened by using rolling coulters suspended ahead of the share. In most cases, these machines cannot be used in forestry operations unless equipped with special devices for turning aside obstructions, or at least with a lift to raise the unit.

One-way plows. Farm plows can be used under easy and even fairly difficult conditions provided they are equipped with the attachments mentioned above. They have the advantage of throwing up ridges, sometimes useful on wet ground, and loosening the soil at less cost partly by deep and partly by surface tillage. They are not suitable for surface scalping work that cannot be carried out with a single moldboard. In fact, on the first plowing trip, since there is no bank to hold it, the one-way plow, when working at shallow depth, jumps the furrow at the slightest obstruction.

Listers or middlebreaker plows. These are like ridgers which turn the soil both to the right and to the left, and do not have the drawback mentioned above. Although in general use in farming, they are not sturdy enough for afforestation work, but special models can be obtained.

Disc machinery

This type of equipment has the advantage over moldboard plows of overcoming obstructions, by either cutting or clearing them instead of jamming into them as does the plow share (Figure 4). However, on shallow soil or where small obstacles are very frequent, such as stones which they cannot lift, disc implements are not satisfactory. They effectively cut up the surface herbaceous cover and turn over the top horizons, but they are usually less satisfactory for raising the soil.

Farm machinery. Disc machines are widely used in farming and many of them can be employed in forestry work. They include implements of the pulverizer type, in particular for tending work; medium weight machines (stubble plows and disc plows) for breaking up a dead and poorly decomposed soil covering, and possibly for subsequent operations; and heavy machines (heavy disc plows or trenching plows) which do a thorough

FIGURE 3. HYDRAULIC UNIT DIGGING PLOW: *William Begg and Sons, Tarbolton, Mauchline, Ayrshire, Scotland.*

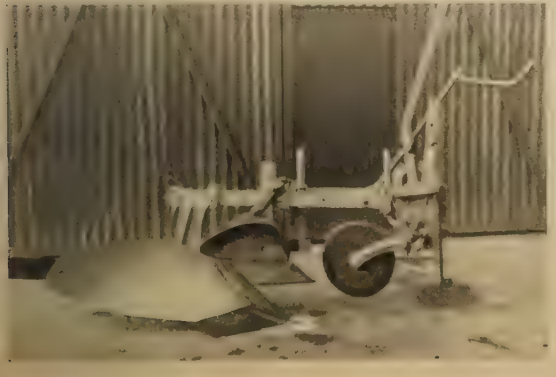


FIGURE 4. DISC PLOW "JARDIN": *R. Jardin, Volnay, Sarthe, France.*

FIGURE 5. ROTAVATOR: *Rotary Hoes of England, Station Road, East Horndon, Essex, England.*

FIGURE 6. ROOTER: *Isaacson Iron Works, Seattle, Washington, U.S.A.*

plowing job when conditions are not too adverse. (In most cases it has been found that with disc implements it is best to reduce the number of discs to avoid tamping, or else to lessen the width cultivated).

Forestry machinery. Generally heavy disc plows with a small number of discs (2 or 3), independent of each other to facilitate tillage when obstructions are frequent.

Horizontal-shaft rotary hoes (Figure 5)

Operated by power take-off. These implements, trailed or mounted, destroy the herbaceous vegetation, break up the dead soil covering and to a certain extent turn over the top layers. It has generally been found that it is better to concentrate the tractor power over relatively narrow rather than wide strips.

Self-propelled machines. These are lower powered machines which differ from the rotary hoe, mentioned for nurseries, only by the shape of the blades. Their handiness makes them very useful for loosening the top soil, namely, superficial hoeing. Those with independent tines pass over small obstructions more easily than the other models.

Tined implements

These implements have vertical teeth and are widely used in farming. There are two types:

(*a*) spike-toothed weeders and scarifiers;

(*b*) spring-toothed, like the harrow cultivator. These are constructed for work under adverse conditions (as in some vine-growing regions) and may be useful for surface loosening in afforestation work.

Vertical-shaft rotary equipment

The fitting of appropriate implements to planting hole diggers, which are dealt with below, will increase the range of their use by making them suitable for surface cultivation.

SUBSOIL TILLAGE TOOLS

These serve for deep tillage and do not bring the subsoil to the surface, which is desirable in forestry work when the soil needs breaking up.

In forestry, much more than in farming, the aim is to facilitate root development. Apart from removing competing plants, deep tillage is often the most useful. Further, whenever there is a danger of water erosion, deep tillage, especially if carried out on the contour, will reduce runoff and increase rainfall penetration. It is to be noted that, whenever possible, it is desirable to do deep tillage before the winter, in order to take advantage of the frosts which help to mellow the soil.

Subsoilers

These implements are widely used in farming and, mounted, can be employed advantageously on dissimilar, often fairly stony, ground, and easily loosen obstructions. Drainer attachments are useful in soils that require drainage.

Rooters

These tools (Figure 6) are used in roadmaking and operate like the subsoiler, but have several tines and so ensure simultaneous loosening better than that obtained by successive trips with a single grubbing standard. They have the disadvantage of requiring a high tractive power.

Modified dozers

Single or multiple-tined implements (grubbers, root-rakes) are fitted to the front of a tractor in place of the bulldozer blade (Figure 7). They do excellent deep tillage under very difficult conditions as they easily clear obstructions. They have the disadvantage of requiring a dozer-equipped crawler tractor and an operator capable of driving it.

Subsurface destruction of vegetation

There are various types of implements that cut the roots, below the surface, of the plant growth to be eliminated. They are not much used in France and wider trials would be worthwhile.

Soil loosening or planting-hole digging

Implements for intermittent work which, when continuous work is not possible owing to excessively difficult conditions, can be very useful in soil preparation. In lighter soils, the mechanical digging of holes should make for better quality planting and, consequently, lower cost with equal work.

Vertical-shaft rotary implements (Figure 8)

Self-propelled tools. Such are power hole diggers. According to the type used, they loosen the soil without removing or lifting it.

Mounted implements. These hole diggers mounted on a tractor or vehicle are operated by the motor of the latter. They do quicker work than those mentioned above but require higher power.

Portable power hole diggers. The gear is mounted on a frame, and the motor operates the rotary movement only. They solve the problem of transportation but call for considerable physical effort on the part of the operator, especially under difficult working conditions.

Percussion implements

These are of the pick-hammer type and can be used for piecemeal subsoiling where ordinary tillage tools cannot operate.

Compressed air implements. These require compressors, and their use in forestry is almost impossible owing to the difficulty of moving them and the problems raised by the frequent handling of the air-intake pipes.

Self-contained units. These may present the same difficulty as the portable power hole diggers.

Terracing or contour trenching equipment

A crawler tractor fitted with a bulldozer and especially an angle-dozer blade, can be used for this type of work which is merely mentioned here as a reminder.

Planting machines

These are machines (Figure 9) generally drawn by tractors which, under exceptional conditions — loose ground free of obstructions, and large areas — reduce the cost of setting out planting stock. Small models of a market-gardening type can be useful in large nurseries.

Special implements

This category comprises the implements constructed to solve a specific problem. They have the advantage of serving the purpose under better conditions and at lower cost, but their use has to be justified by the existence of large areas with similar conditions.

CHECK LIST OF PLANTING EQUIPMENT SUGGESTED FOR USE BY FOREST OWNERS IN FRANCE

A. *Nursery care*
   1. Power cultivators
   2. Rotary hoes
      (*a*) Self-propelled rotary hoes
      (*b*) Rotary hoes fitted to power cultivators

B. *Clearing of surface vegetation*
   1. Herbaceous vegetation
      (*a*) Cutter bar front-mounted power-driven mowers
      (*b*) Front-mounted cutter bars attachable to power cultivators
   2. Woody vegetation
      (*a*) Trailed brush cutters
      (*b*) Vertical-shaft brush cutters
      (*c*) Front-mounted scrub-clearing equipment

C. *Surface soil cultivation*
   1. Moldboard plows
      (*a*) One-way plows
      (*b*) Listers or middle-breakers
   2. Disc machinery
      (*a*) Farm machinery
      (*b*) Forestry machinery
   3. Horizontal-shaft rotary hoes
      (*a*) Operated by power take-off
      (*b*) Self-propelled machines
   4. [illegible]
   5. [illegible]

D. *Subsoil tillage*
   1. Subsoilers
   2. Rooters
   3. Modified dozers
   4. Subsurface destruction of vegetation

E. *Soil loosening or planting-hole digging*
   1. Vertical-shaft rotary implements
      (*a*) Self-propelled tools
      (*b*) Mounted implements
      (*c*) Portable power hole diggers
   2. Percussion implements
      (*a*) Compressed air implements
      (*b*) Self-contained units

F. *Terracing or contour trenching equipment*

G. *Planting machines*

H. *Special implements*

(*Article translated from an original French text*).

FIGURE 7. CONTINENTAL TRACTOR 7200, *equipped with three-tooth grubber.*

FIGURE 8. MECHANICAL EARTH AUGER MODEL III: *Les Fils d'Albert Collet, 41 rue Cardinet, Paris 17, France*

FIGURE 9. TREE PLANTING MACHINE: *Forestry Equipment Company, Jacksonville, Florida, U.S.A.*

Equipment News

Interest in the development of forest utilization and woodworking industries is reflected in the continual demand for information on new equipment. The Forestry Division, FAO, collects such information and passes it, on request, to Member Governments; a selection is published here. FAO accepts no responsibility for the claims of manufacturers.

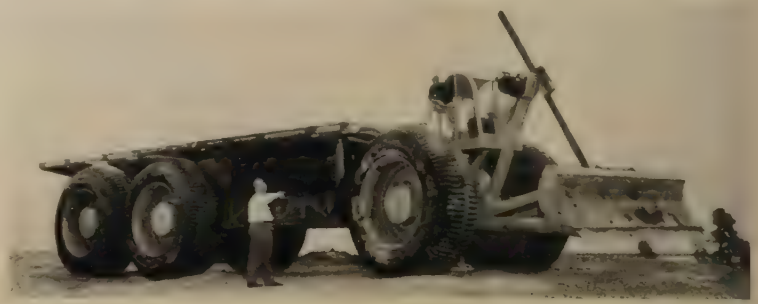
MARCONI DT45-C MOBILE UNIT. FM mobile station for operation in 152-174 MC band. Power output of transmitter 50 watts, sensitivity of receiver 0.4 microvolts for 12 db (decibel) to noise or 20 db quieting. Withstands extremes of temperature, humidity, vibration and shock. Dynamic microphone and low-distortion receiver; less than 3 % distortion for 1.5 watts output. Universal design permits instantaneous changeover from 6 to 12 volt supply.

Canadian Marconi Company, 2442 Trenton Ave., Montreal 16, (Quebec), Canada.

TREE-CRASHER. — Giant jungle destroyer designed to uproot heavy trees and underbrush. Large-size trees are pushed down with the blade raised about 10 ft. (3 m.) in the air; smaller, medium-size trees and underbrush are uprooted and carried away in one continuous operation with lowered blade. Each of six giant wheels has individual electric motor and gear reduction driven by generators, driven in turn by two powerful diesel engines. The pressure of machine upon ground is about that of a walking man, so it is well suited for work on swampy or sandy ground.

Top of crasher forms platform 39 ft. (11.8 m.) long and 11 ft. (3.3 m.) wide which can support more than 200,000 lb. (90,720 kg.).

R. G. Le Tourneau, Inc., 2399 South MacArthur, Longview, Texas, U.S.A.



DANARM FALCON WINCH. — Can be carried over heavy ground to site and fitted in few minutes to Fury or Whipper Danarm chain saw engine in place of guide blade and chain, transforming it into tool for hauling, pulling or lifting. Heavy-duty ground anchor available. Weight (approx.): 20 lb. (9 kg.) less line; drum capacity: 125 ft. (38 m.) of ¼ in. (6.4 mm.) cable; roller type bearings; lifting capacity: with Fury engine 15 cwt. 2 lb. (765 kg.), with Whipper engine 9 cwt. 2 lb. (458 kg.).

J. Clubley Armstrong Danarm Ltd., Abford House, Wilton Road, London S.W.1, England.

ROOTER MODEL M.53-A. — Extra heavy duty rooter engineered for use behind any 85-100 hp. crawler tractor. 5 shanks easily removed as well as plow steel shank teeth.

Full hydraulic control on 30 in. (75 cm.) penetration; heavy 2 × 9 in. (5 × 23 cm.) shanks; 36 in. (90 cm.) tyres.

Murray Manufacturing Company, 510 River Road, Modesto, California, U.S.A.

HOMELITE BRUSH CUTTER ATTACHMENT. — In few minutes the chain saw can be converted into a brush cutter for clearing areas overgrown with brush, weeds and small saplings up to 3 in. (7.5 cm.) diameter.

To be mounted on a Homelite 17 model; power 3.5 hp; weight 22 lb. (10 kg.) approx.

Homelite Corporation, Port Chester, New York, U.S.A.

SCHULSTAD MOBILE CIRCULAR POWER SAWS. — Manufactured in four sizes:

Model 30: blade size 30 in. × 11 gauge (76 cm. × 3.0 mm.); 5 hp single cylinder two-stroke engine. Weight 2 cwt 1 qr. (approx. 103 kg.); angle of cutting adjustable through 360° self-locking in any position; can be operated with blade rotating. Useful for fire wood cutting and general utility work.

Model 30 A: As model 30 plus reversible axle allowing absolute ground-level falling of timber. Equally effective when used with special rotary knives for fern or bracken cutting.

Model 36: Heavy duty self-propelled machine; blade size 35 in. × 10 gauge (89 cm. × 3.3 mm.); 10 hp air-cooled twin cylinder two-stroke engine. Power drive forward and reverse.

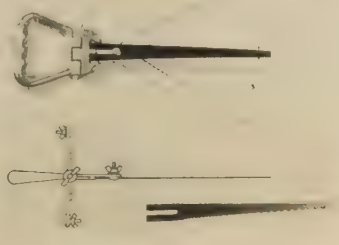
Model 48: Blade size 48 in. × 10 gauge (122 cm. × 3.3 mm.). Suitable for very large timber and for work in rough country.

W. Schulstad, Engineers, 26 Hardey Road, Maylands, Western Australia.

OLIVER JET TRENCHER. — An addition to OC3 Tractor loader (approx. 22 hp). Adds extra versatility without limiting tractor maneuverability or loader operation. Attached or detached in 90 sec. *Specifications*: digs to 12 ft. (3.6 m.); loads to 7 ft. 4 ½ in. (2.2 m.). Boom swing 180°. Attachment is hydraulically operated by 2 point hitch.

Buckets available in sizes from 12 in. (30 cm.) to 36 in. (90 cm.). 14 in. (36 cm.) width is standard.

The Oliver Corporation, 400 West Madison Street, Chicago 6, Illinois, U.S.A.



CAGO UNIVERSAL SWIVEL-SAW. — General purpose saw with blades suited to both metal- and woodwork. Handle permits blade to approach work at any angle. Blade is tungsten steel for cutting metal, carbon steel for wood.

Cago (Sales) Ltd., Vernon House, 510 a, Coventry Road, Birmingham 10, England.

CARRIAGE WITH CLAMPING-DOG AND TELECONTROL BOX. — Eliminates all labor other than the sawer allowing 10 to 20-sec. clamping. 2-direction motion of dogs; clamp first opens to fit shape of log and grip uniformly. Log is then aligned to blade, to allow sawing with grain of wood.

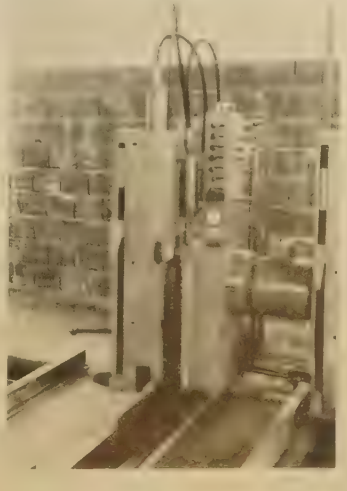
A loader allows loading of carriage and turning of logs during sawing operation by remote mechanical or hydraulic control.

Ets. Rennepont, 69, Quai de Valmy, Paris X, France.

CHEVROLET TRUCK EQUIPPED WITH A POWR-PAK 4-WHEEL-DRIVE. Chevrolet ½-¾-1-1½ and 2 ton trucks can be equipped with Powr-Pak 4-wheel-drive, transferrable from one truck to another without damage to frame. Shifting in or out of 4-wheel-drive is done without stopping or clutching.

Truck equipped with this 4-wheel-drive climbs up to 70 % grades, while transporting logs, equipment, supplies and personnel; can also serve for snow plowing, hauling and road maintenance.

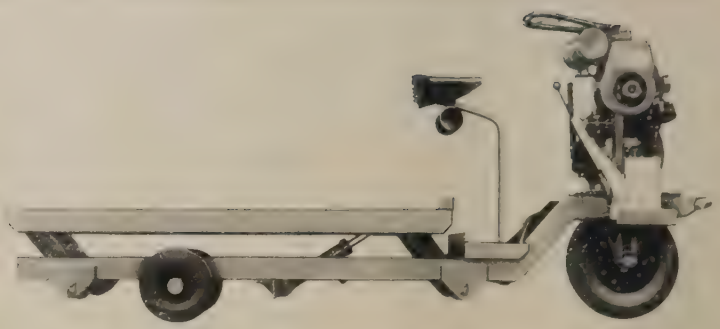
Napco Products Division of Napco Industries Inc., Minneapolis, Minnesota, U.S.A.



RUDDAN CANT HOOK. — Enables one man to turn logs to any position while still away from machine, to bring them quickly to best position for clamping, also to turn logs already barked or partially squared.

Specifications: Electrically-driven; weight approx. 25 kg. (55 lb.). Consists mainly of switch or relay box to be attached to carriage of hoist and tackle, a control box with 2 push buttons, wires relaying switches to motor and contacts to buttons, and manipulation chains.

Ets. Ruddan, 31, rue de la Croix de Fer, Saint-Germain-en-Laye (Seine et Oise), France.



PYRAMID HYDRAULIC PLATFORM TRUCK MODEL 107. — Designed for operating in conjunction with stillage. Fitted with foot-operated hydraulic pump to raise platform and lift stillage. *Specifications*: Loading platform: 59 ½ in. × 26 in. (151 × 66 cm.); weight: 610 lb. (277 kg.); load 1,750 lb. (800 kg.); max. speed: 6 mph (10 km/h); platform elevation: 6 in. (15 cm.); 4-stroke air-cooled petrol engine 1 ¼ hp. 120 cc.

The Excelsior Motor Company Ltd., Kings Road, Tyseley, Birmingham 11, England.

FORK LIFT "SKID STAC". — Load carrying plate and push-pull rack fitted with gripper blade, operated from truck hydraulic system. Rack supported by horizontal telescopic slides on each side. Push-pull and gripping blade mechanisms automatically sequenced by valve causing blade to grip before rack retracts and to release before rack extends.

In three models:

E3-20 for loads from 1,570 to 3,000 lb. (712 to 1,360 kg.);
E4-20 for loads from 2,380 to 4,000 lb. (1,079 to 1,814 kg.);
E45-20 for loads from 2,950 to 4,500 lb. (1,338 to 2,041 kg.).

Fork Trucks Ltd., Warrington, England.

DOUBLE DRUM SANDING MACHINE, TYPE BD-B. — Heavy cross-girted frame forming rigid mounting for sanding drums and pressure platens. Vertical adjustable conveyor unit with variable feed range. Special features allow either finish sanding with flexibly mounted conveyor, or thicknessing with rigid conveyor and flexible top front pressure. *Specifications*: Width admitted: 36 in. (91 cm.) and 42 in. (107 cm.); max. thickness admitted: 6 in. (15 cm.); feed speeds infinitely variable from 14 to 35 ft/min. (4.2 to 10.7 m/min.); width of abrasive paper on both sizes of machine: 24 ¼ in. (61.5 cm.).

T. White and Sons Ltd., Laighpark Works, Paisley, England.

News of the World

The items appearing here are condensed from newsworthy material collected by FAO staff or submitted by corre[illegible]. FAO assumes no responsibility for statements and statistics in items accepted in good faith from contributors.

Afghanistan

• An FAO officer visiting Kabul reports on the privately-owned plantations of black poplar which are plentiful around the capital alongside irrigation channels. They form a feature of all the valleys of the country. All the plantations show the same defects, which could no doubt be easily remedied: use of any kind of cuttings or slips for planting with the result that trees are often misshapen; insufficient spacing sometimes only 10-15 centimeters between the planted slips and no systematic thinning; complete ignorance of pruning techniques.

A timber depot situated just outside Kabul has a turn-over of 40-50,000 poplar logs a year. As there are five of such depots in all, and others not quite so large, and as some supplies are obtained by owners directly from their country estates, local consumption can be estimated very roughly at 25,000 cubic meters of roundwood. Prices range from 100 afghanis (official rate of exchange US $1 = 21 afghanis: market rate, 40 to 43 afghanis) for a barked log 10 meters long and 25 centimeters in diameter at the thick end, to 5 afghanis for a pole 3 meters long and 8 centimeters in diameter.

Local furniture makers are equipped in a fairly modern way, though production is not greatly rationalized. The wood used is mainly cedar from Nouristan, delivered by floating, or hauled by pack-horse from Janubi: walnut is also used. The cedar squares are priced at 120 afghanis delivered. Entirely squared by axe in the forest, this method of exploitation represents a considerable wastage of wood.

Australia

• The results of research in reproducing vegetatively Radiata pine, which began in Australia in 1937, may be summarized as follows.

The more important factors influencing successful rooting of cuttings are: age of the tree from which cuttings are taken, the inherent nature of the individual tree for reasons not evident, and the season of collection of cuttings. In addition, the type of branchlet employed, nature of the rooting medium, length of the cutting, depth to which set, water supply, and the aeration of the base of the cutting may be important. Cuttings from young trees are generally superior to those from old trees; cuttings are best collected when terminal buds are resting after the heat of summer; first order branchlets are preferred; cuttings may be pulled from the tree and cut to length with a sharp axe; needles are not stripped from the base of the cutting.

Cuttings raised in nursery beds are poorly rooted and suffer severe loss in plantations. A method using galvanized iron tubes 6 inches long and 1 3/4 inches in diameter has been developed to give far superior plants and survival. Cuttings 6 inches long are used and set at a depth of 3 inches in the soil tubes which are then placed in the open nursery in rows, the base of the tube being set no deeper than is necessary to keep the tube upright. While this method is more expensive than others, it gives a higher percentage of success and better quality plants.

Bulgaria

• Ownership of the forests was formerly spread as follows: communal, monastic and school made up 57 percent; State, 26 percent; and private, 17 percent. In 1944, all forests were declared State property.

According to the latest statistics furnished to FAO's European Forestry Commission, forest land represents 33 percent of all the territory of the country — about 28 percent being tree-covered. This shows that the wood production potential of the country is considerable, being 5 percent higher than the average for Europe.

High forest forms 60 percent of all wooded forest-land, about 14 percent coniferous and 46 percent deciduous. In the latter, beech is the most important species and is one of the main sources for supplying the demands for construction timber. Oak forms just over 3 percent of the area of high-forest.

Coniferous forests comprise mainly common pine and black pine, which occupy 69 percent; spruce, 23 percent; black fir, 0.5 percent; and the rest of the area is taken up by common fir and larch.

For management purposes the forests are divided into seven categories: the protective, water-regulating forests occupying 50.7 percent; the State forest-belts, 0.4 percent; health-resort forests, 1.8 percent; preserved forest, 0.2 percent; forests of the green-belt, 1.8 percent; eroded forest-lands, 6.8 percent; and protective-industrial forests, 38.3 percent. This differentiation of the forests according to their significance for the national economy enables the forestry administration to organize and manage them on a sound basis.

Measures are planned to convert much of the coppice and low-growth forest to high forest. These types occur largely on the plains and in the foothills where they fulfill a definite need in the rural economy for fuel, small building material, and fodder.

A radical reform in the organization of the rural economy has taken place, and a wide network of workers' co-operative and State farms has been set up. These must manage and can use the timber of the woodlands occurring on them, which gives the agricultural farms a material interest in planting up those lands that are unsuited to farming use.

In view of the great demand for wood for building, for some years it became imperative to allow an increase in the rate of cutting of coniferous forests. Subsequently, the Government took measures to bring about the substitution of wood by other building materials, and then reduced the rate of utilization of the forests to normal. At the present time, the basic problem in forest management in the high mountain regions is to combine the maximum timber-exploitation with the retention of the protective functions of the forests to the maximum extent. This is achieved by introducing the most suitable systems of felling. In high forest, both coniferous and deciduous, the trend is towards progressive and group-selection fellings, whereby a gradual renewal of the mature crop is secured and favorable conditions created for the development of young growth. In the upper reaches of the forests, on steep slopes and in the region of reservoirs, only selec-

... practiced. Clear-felling ... high forest is forbidden and is only ... in forests of low-growth where ... felling cycle is 20 to 30 years.

Canada

• The Junior Forest Wardens movement, under the sponsorship of the Canadian Forestry Association, was started 25 years ago as the Junior Fire Wardens. The movement is dedicated to the study of forestry, woodlore, fire prevention, fire fighting, conservation of forests, signaling, first aid and many other activities that parallel professional work in the forest. Projects include the growing and planting of trees, acquiring proficiency in woods-travel, camping trips, tree and plant identification, making woodland inventories, in general assisting forestry and game departments.

Beginning in British Columbia where the active membership has grown to 6,500 and more than 32,000 of the familiar red-shirted wardens, with proficiency badges on their arms, have graduated, the movement has spread to Ontario, the Maritime provinces, Newfoundland, and the United States, Australia and New Zealand, and is still growing. Membership is open to all boys attending school between the ages of 10 to 16 and their enrollment card is signed by a Forest Ranger, principal of the school or a group leader.

• A light meter that will aid biologists to measure the amount of light received by trees and plants has been developed by the National Research Council and the Forestry Branch, Department of Northern Affairs and National Resources. Measurement of light is important to those scientists who study the effect of environment on plant growth but previous light recording instruments were unsuitable. The pyrheliometer used by meteorologists and the exposure meter of photographers records the amount of light received by flat surfaces only, while plants are affected by light from all directions.

To record the light coming from all directions, a glass sphere 4 inches in diameter is used in the new instrument. Light striking the globe passes to a photoelectric cell causing an electric current to operate a counter. Readings of the counter are taken at the start and end of the observation period. Because plants respond mainly to the light wave lengths lying in the visible part of the spectrum, the integrating light meter is sensitive to those wave lengths only. Tests at the Petawawa Forest Experiment Station have been satisfactory and forest biologists describe the meter as a "useful and flexible instrument" for a wide range of experiments on the effect of light on tree growth.

Ceylon

• A correspondent points out that the photograph appearing on page 135 of *Unasylva* Vol. 9, No. 3 is a picture taken in the "wet patanas" of Ceylon. These are high elevation montane grasslands, above 5,000 feet altitude, of a sodden and peaty type as may be observed in the photograph. The nursery in the course of preparation was for raising plants of *Pinus caribaea* for the "wet patana" scheme which consists of afforestation in solid blocks mainly with *Acacia mollissima*, not a windbreak cum pasture scheme. This nursery site was subsequently abandoned as it was too windswept for the purpose of raising plants.

The forest in the background is typical of the stunted variety of wet evergreen forest found in this region.

Costa Rica

• A Fifth International-Tropical Training Course was held from 5 to 30 September in Turrialba with 26 students from Mexico, Guatemala, Honduras, El Salvador, Nicaragua, Costa Rica, Dominican Republic, Cuba and Puerto Rico. The staff consisted of two professors from Mexico, Dr. Enrique Beltrán and Ingeniero Villaseñor, Dr. L.R. Holdridge from the Inter-American Institute of Agricultural Sciences (IIAS), Mr. H.C. Haines from the International Co-operation Administration of U.S.A. (ICA) in Costa Rica, Mr. P. Poyry and Mr. Schreuder from FAO and various other technicians in different fields, from Costa Rica and the IIAS in Turrialba. About 10 days of the course were dedicated to lectures, the rest of the time to field work and visiting industries, experiment stations and various forest types in the country. Almost all of the participants of this course are working in the various Forest Services of their respective countries; some of them in agricultural extension. Their average educational background was very satisfactory, and all of them took part in the course with appreciable interest, in the theoretical part as well as in the practical field work.

Ecuador

• In Ecuador, there are approximately 2 million hectares of *páramos*, grassy regions above the natural timberline. Their lower altitudinal limit is usually at about 3,500 meters, and the upper limit permanent snowline at some 4,500 meters. The greater part of these *páramos* is not being used.

Some 27 years ago, on the *páramo* on the slopes of the volcano Cotopaxi, at 3,600-3,800 meters above sea level, small plantations of Monterey pine (*Pinus radiata*) and cypress (*Cupressus macrocarpa*) were established and have proved moderately successful, in spite of the fact that neither of the species used grows naturally at such high elevations.

The entire inter-Andine sierra region of Ecuador depends almost entirely on plantations of *Eucalyptus globulus* for fuel, charcoal, construction timber, railway crossties, and even flooring and cheap furniture. Most of these Eucalyptus plantations are on land potentially agricultural in nature. It therefore seemed important to initiate experiments to determine what other timber species could be grown to best advantage in the *páramos*. William R. Barbour, an FAO Technical Assistance officer, has been assembling seed for the purpose of establishing small trial plantations on the Cotopaxi *páramo*. Already received and planted in seedbeds are coniferous species from Italy and Morocco and 12 kinds of *Eucalyptus* from Peru. En route from Australia are seeds of 18 species of *Eucalyptus*. Orders for seed have been sent to Kenya and Taiwan. Seeds of Himalayan species will be obtained from Dehra Dun, India, and it may be possible to obtain seeds of trees from the high mountains of Mexico and Central America. It is hoped to establish trial plantations of some 50 species, of which a few may prove suitable for extensive introduction.

Finland

• As from 1929, the State has granted forest owners subsidies and loans for basic improvement in their forests. Stipulations governing the funds allocated for this purpose are included in the Forest Improvement Act which is passed for five-year periods. Under the 1953 Forest Improvement Act now in force, at least 600 million marks are granted every year for afforestation of treeless land; reforestation of under-productive forests; forest drainage; construction of forest roads; and a certain amount of research in the above-mentioned fields.

The funds are granted either as loans or as subsidies. As a rule, loans are repaid at an annual rate of 6 percent, but for loans for road construction the rate is 10 percent,

3 percent being interest and the remainder amortization. Subsidies can be granted up to 6 percent, in exceptional cases up to 8 percent. In granting subsidies and loans, the total size of the holdings and in general the economic resources of the persons qualifying for them are taken into consideration, and generally the owners of small woodlands are the most favored.

France

• With its twelfth issue for 1955, the *Revue du Bois et de ses Applications* completed the tenth year of its appearance. The quality of its articles, the high standard of presentation and the wide interest of the features which it includes have established for this review a distinguished place not only in France but also among all periodicals dealing with forestry and forest products.

One of the characteristics of the *Revue* is that it sets out to strike a balance between forestry, wood utilization, and trade and industry, and always considers the timber situation against the background of the general French economy, and then against the world economic picture.

Among those who produce the *Revue* or contribute to it articles of enduring interest, are many particular friends and helpers of FAO. The Forestry Division of FAO is therefore happy to take this opportunity of congratulating them on their work and to wish them continued success with the *Revue du Bois*.

• The forests of France are highly diverse in composition and quality, resulting from the varied combination of climate, topography, geology and soils and from the complex history of two millenia with its use and abuse, attention and inattention, advance and retreat. Since the Roman occupation the forests have felt the impact of clearing for agriculture, the taking of wood for fuel and later for industry, the establishment of destructive usage rights, the reservation for hunting, of fire and erosion. Concern over the forests appeared in 1280 as a forest code for the Royal forests, which set up an organized forestry service, followed by others and at length by Colbert's famous ordinance in 1669, which survived the Revolution and inspired much of the code of 1827. The foundation of the National Forestry School at Nancy in 1824 under the great Bernard Lorentz, an Alsatian, led to the production of fully equipped cadres to administer the State forests and, even more importantly, to the introduction of the theory and practice of natural regeneration, largely responsible for the renascence of French forestry during the past century.

The great forest destruction of the first world war and the lesser evils of the second world war have finally led to the recent formulation of a vast forestry program, dealing with both State and private forests, and to its implementation by a National Forestry Fund.

All this is described in *Forests of France*, written by J. L. Reed in English. This is an interesting and well-written book, necessarily sketching rather than dealing in great detail, but containing a surprising lot of information, sufficient for its purpose. It is a very real achievement for a foreigner to have understood and reported the story so well.

• The Law of 30 September 1946, which established a National Forestry Fund, has made it possible to achieve great progress in afforestation in France. In the first eight years around 500,000 hectares of new plantations, mostly conifers, have been created.

This expansion of artificial stands for an essentially economic purpose has led the French forestry administration to try to improve on traditional planting methods which are sometimes ill-suited to modern conditions and the objectives of the whole planting scheme.

For this purpose, early in 1951, the Ministry of Agriculture set up an advisory committee on forest planting to advise and make recommendations on:

1. technical problems of afforestation projects;
2. species and methods to be used in each major natural region, depending on the environmental conditions;
3. principles that should govern priorities accorded to particular afforestation projects in annual planting programs;
4. demonstration and pilot projects.

The committee brings to bear on the problems presented to it, the combined knowledge of the three component parts of the Waters and Forests Department, responsible for implementing the afforestation policy, namely, the Central Administration, the Research Service and Field Service. Each is represented by several Conservators and Officers of the Waters and Forests Department, thus making for close and effective co-operation. The members from the Field Service are periodically changed so that the Committee becomes acquainted with the particular problems of the various regions of France. The Committee meets in Paris three or four times a year and makes field trips. It may invite prominent personages to participate in its meetings, particularly private owners and representatives of forestry and timber firms.

During its first year of functioning, the Advisory Committee made a broad survey of the planting problems in the various regions of France, so as to select those specific problems that merited thorough expert study. The results of such studies, and the Committee's agreed solutions, have been written up in the form of reports and published in a collection entitled *Comment reboiser* (How to Plant). Nine reports have already been issued, in editions of 8,000 copies each. They cover the following subjects:

(*a*) choice of species;
(*b*) conditions and methods peculiar to the heavy soils of the west;
(*c*) methods of soil preparation;
(*d*) soil improvement methods;
(*e*) protection against pests and diseases;
(*f*) planting maritime pine on the 'Landes' of Gascony;
(*g*) use of Douglas fir in afforestation;
(*h*) afforestation by direct seeding.

The use of machines in planting work and the types that can be used are explained in Pamphlet No. 8: *Mechanical Equipment and Afforestation*, the main features of which appear in the Equipment Section of this issue of *Unasylva*.

These titles indicate the main preoccupations of the Committee which has laid particular strees on correct soil preparation.

Their publication represents one side of practical achievements of the Advisory Committee during the first five years of its existence, but its activities have grown much wider, and, for instance, its opinion was sought on the 1952-57 Planting Program, and it has drawn up or suitably modified the precise regulations for contracting agencies carrying out planting operations.

French Guiana

• The forests of the Department of Guiana cover a large part of the country and amount to about 7 million hectares, of which 1.5 million hectares can be exploited fairly easily. Surveys carried out so far seem to

indicate enough valuable timber to the hectare to make large-scale exraction an economic proposition. The topography of the country, intersected by large rivers, makes the transport of logs easy during most of the year.

Local consumption requirements absorb most of the timber logged now but exports might find markets in the French Antilles, the West Indies, America and even Europe.

The Guiana forests contain many species of varying properties. Among the best known species which occur in some quantity are Angelique (*Dicoryria paraensis*), Wapa (*Eperua falcata*), Parcouri (*Ocotea rubra*), Manil (*Symphonia globulifera*), and Yayamadou (*Virola surinamensis*).

The present sawnwood production of Guiana is low because the sawmills are poorly equipped. Even so their capacity is much greater than the logging concerns can supply. These do not have the resources to buy modern logging equipment. The sawmills are equipped with circular saws, Canadian type, requiring considerable driving power and producing only poor-grade lumber.

To improve agriculture and more especially forest exploitation in Guiana, the Government set up a State Company, *Le Bureau agricole et forestier guyanais*, in 1946. A forest inventory was started. It is still in progress, but appears to reveal that the forest could besides sawlogs yield veneer logs and pulpwood. An experimental sawmill is now operating in the Saint-Laurent du Maroni area, with various types of saws, adapted for sawing the different species of the Guiana forests. The results obtained are publicized as widely as possible for the benefit of the existing sawmills and to encourage the establishment of new mills. Experimental plots have been established for studying the regeneration methods best adapted to the Guiana forests.

Germany

• *Aus der Hohen Schule des Weisstannenwaldes* by K. Dannecker, although written primarily for the Central European forester, deserves attention on a much wider geographic range. It deals with the problems associated with large-scale plantations of uniform stands particularly of spruce, established during the past century in many parts of Central Europe and particularly in Germany. This practice, chiefly in connection with the wide adoption of the management system customary for monocultures, namely clear cutting, has resulted in a rapid diminution of valuable species native to these regions. In particular silver fir (*Abies alba*) has receded to an alarming degree in many hilly parts of Germany, thus creating the catchword of "fir dieback" or of "the lost species." This situation would probably not have given much reason for concern if the uniform spruce or pine forests established in place of the original mixed fir hardwood forests, had not frequently resulted in dangerous soil degradation, increased susceptibility to biotic pests, and severe snow and wind damages, as well as progressive decrease of site productivity.

The author's conclusion is the same as that of another, J. Weck, namely that the basis of forest management methods aiming at the highest possible sustained wood production on a given site must be a thorough investigation of the natural laws which govern the growth of individual trees and the production of entire stands. Substantial progress in this direction has been made in recent years in many countries, through more careful thinking, inclusion of the biological aspects of plant ecology and sociology, forest hygiene, and through new mathematical approaches.

Forstliche Zuwachs und Ertragskunde (FOREST INCREMENT AND YIELD) by J. Weck endeavors to bring together in very concise form currently available information on an international level, as to the various aspects and theories of increment and yield, for forests from the northern regions to the tropics. The author draws conclusions and gives attention also to the many problems that still remain to be solved, in face of the fact that each separate stand of trees is different in appearance, environment and requirements.

India

• N. J. Masani, who lectures on engineering and surveying at the Indian Forest Colleges in Dehra Dun, has prepared *Notes on Forest Engineering* "with a view to assisting forest officers, with a limited technical knowledge and with little practical experience, to construct forest engineering structures which very often they are required to do, using minimum materials and thus conducing to economy of public money." The book, intended primarily to serve as a textbook for forestry students, contains chapters on building materials, masonry, erection, carpentry and joinery, timber mechanics, roadmaking, bridges, and water supply. A large amount of useful information acquired through practical experience is provided, and the book may therefore find a wider use than intended by the author, particularly as a guide to forest officers working in countries or conditions comparable to those in India.

Mexico

• Reporting to the Latin-American Forestry Commission, Mr. L. Huguet, an FAO Technical Assistance officer in Mexico, described the Mexican Forest Service as being as old as that of the United States, although it had not made the same extraordinary progress. In 1951, at the request of the Government, FAO sent a large forestry mission to help the authorities in technical and policy matters. This mission completed its work in 1953 and, to assist in implementing some of the mission's recommendations, FAO has since sent other experts to the country. One expert in pulp and paper research co-operated with the Mexican Institute for Technological Research of the Bank of Mexico (*Istituto Mexicano de Investigaciones Technologicas del Banco de Mexico, S.A.*) in assessing the various raw materials that can be used for the production of the types of paper that Mexico requires. Mexico is fortunate in having all the standard or unconventional raw materials needed for the production of pulp and paper. Another adviser on the marketing of forest products is studying both export problems and the development of local markets.

Two experts, one a forester and the other an industrial specialist, are advising on the setting-up of a chain of integrated forest industries in the State of Michoacán, the final goal of which is to produce 40,000 tons a year of newsprint, 30,000 tons of sulphate pulp and over 60,000 cubic meters of sawn timber. The last project has already been planned and an allocation of funds approved by the Mexican Government.

New Guinea

• In New Guinea, the bark of some mangrove species is used for the development of tanning extract, but no use is made of the timber. Pulping studies by the Australian Commonwealth Scientific and Industrial Research Organization on five species of a mangrove association, using the sulphate process supplemented by chemical and morphological examination, show that the chemical characteristics are similar to those of other hardwoods and that pulps of good strength properties are obtainable from three of the five species tested. These species are *Camptostemon schultzii*, *Sonneratia acida* and *Ex-*

coeacaria sp.: their pulps appear to be similar to, or even better than, corresponding pulp from *Eucalyptus regnans*.

New Zealand

• During the thirty-odd years since it was set up, the Forest Products Branch of the New Zealand Forest Research Institute has amassed a great deal of information on New Zealand and overseas timbers. Some has been published and more is being published but it is an inescapable fact that available data stimulates enquiries. Research tends to be interrupted by constant requests for information which are met, with varying degrees of success by letter, telephone, lectures and publications.

Some of the more important and time-consuming items are:

1. Grading of timbers including developmental, training (courses), committee and even checking work: in addition to exotic softwood grading, current interest relates to native softwood, for which the existing rules are no longer logical, and the beech timbers.
2. Building timbers — a very live issue with the present changeover from familiar to unfamiliar timbers including some imported ones: building specifications and codes do not just spring into being — they evolve very slowly; at present a revised light timber code and one for structural design are taking shape.
3. Utilization of minor timbers.
4. Industrial uses: current studies include farmers' needs, peeled veneer match-boxes, flooring (including end-matched), bridges, railway needs, cross-arms, poles and a host of others.

• The New Zealand Forest Service is attempting to meet its increasing requirements of permanent skilled forest workers by recruiting and training young men as woodsmen. These will form a permanent and efficient labor force of craftsmen trained both in forest work and the associated trades.

The type of boy selected must be physically fit and attracted to healthy, interesting, outdoor occupation. He should be between 15 and 17 years of age and have had one or two years' secondary education.

The training given in two established schools extends over four years, and covers all the essential jobs connected with forestry. Teaching and supervision is carried out by carefully selected Forest Officers and technicians, and aims at turning these junior woodsmen into useful citizens, well adapted to fulfill the national forest development program which ranks in importance with other major industries in New Zealand. The syllabus includes the care and management of native and exotic forests; timber appraisal; nursery work; planting, pruning and thinning; logging and extraction; elementary surveying; wood-working; fencing; care and maintenance of mechanical equipment; first aid instruction; fire prevention and communications. The importance of the boys' physical and mental welfare during training, which occurs at a most critical period in their lives, is fully recognized and met.

Woodsmen who display aptitude for certain work are encouraged to specialize and salaries are then commensurate with the specialized skill attained. Those who fail to reach the required standard may, if they wish, become unskilled Forest Service workmen whose continued employment is guaranteed if conduct is satisfactory.

Another form of technical training is for boys who have their school certificates and are between the ages of 16 and 20. They spend the first year of their career on a forestry station, gaining experience in the manual skills of forestry. This helps them decide whether they want to make forestry their career, and gives the Forest Service an opportunity to learn about the individual trainee. Practical knowledge is necessary to the boy who, in a few years' time, will be in charge of men doing similar work.

Toward the end of the first year there is a division in the scheme of training. Successful candidates whose ability is academic and who have the university entrance or higher examination are offered university training in the technical aspects of forestry, and can become professional foresters. Those of a more practical bent can carry on field work for training as forest rangers.

The trainee selected for degree study is afforded opportunity for part-time attendance at a university, which means that he will take four years to graduate as B.Sc. after which he may even be sent to an overseas forestry school for post-graduate training.

Those who continue with field training only attend special "technical" courses, and gain experience in the control and handling of men. When they have reached a sufficient degree of proficiency, they are promoted to Forest Ranger.

Nigeria

• Until very recently, whenever the need arose to carry out any project of timber research, timber firms in West Africa had to turn to research institutes in Britain for assistance. Co-operation was invariably forthcoming but many difficulties were created by the 4,000-mile separation of the mills from the laboratories. The greatest drawback was the virtual impossibility of reproducing in the United Kingdom exact tropical conditions on more than a limited "hot-house" scale.

In order to facilitate the development of the timber industry in West Africa, a commercial firm decided to establish its own timber research unit at Sapele, and this unit is the only private timber research organization in the whole of British West Africa.

The construction of the unit started in 1954 and is now approaching completion. The initial capital outlay amounted to £30,000, and the annual operating costs are expected to be substantial. The unit comprises a completely equipped laboratory and many woodworking machines, together forming a plant which can perform on a small scale all the operations of the mass producing factory, thus enabling detailed pilot tests to be carried out.

Investigations will cover the treatment of logs from the moment the trees are felled. The improvement of timber processing, ways and means of improving the quality of the timber products, and achieving more efficient production, will all be subjects for research. In addition, the unit will undertake quality control, paying special attention to the problems of timber preservation, and conducting research both into wood-boring insects and into effects of fungus attacks. The results of research at Sapele will be co-ordinated through a laboratory in the United Kingdom with research performed elsewhere.

Norway

• Around the turn of the century, forest owners began to organize themselves in local societies. But these local organizations did not solve the forest owners' problems and, in 1913, a national association was formed. In 1929, this association was reorganized and district pools were formed for the purpose of selling the members' timber.

The Norwegian Forest Owners' Association is built up as follows:

1. *Local societies.* These are community organizations of which

... forest owners are members (membership is not compulsory). The owners are the actual producers. Each one reports to his local society how much timber he has for sale.

2. *Sales or marketing pools.* These are district organizations and each generally includes the local societies in that district. The local societies report to their sales organization how much timber each has for sale, and the sales organization then finds a buyer among the pulp and paper mills or sawmills.
3. *The central unit.* The chief aim of this unit is to work for the economic and vocational interests of the forest owners, and to present the viewpoint of the forest owners to the authorities and the public.

At present the Association comprises 21 affiliated district pools or sales organizations. Each member pays a registration fee when he joins the organization and a commission to the district organization for the amount of timber sold on his behalf. This commission furnishes the necessary running expenses. The Association issues an information magazine, *Skogeieren* (THE FOREST OWNER) which forms a link between members and has about 40,000 readers.

The question of credit has been an important item on the program of the association. Formerly the forest owners had to depend on the timber buyers for the advance money they needed to finance their operations. Now the question of credit has been solved and the forest owners can borrow the advance money they need from a rural credit organization, the Farmers' Society for Short Term Credit.

Among the problems on which the Norwegian Forest Owners' Association is working today is that of strengthening the local societies of timber producers and increasing their membership. Furthermore, the Association is seeking to extend the activity of the district pools or sales organization so as to include not only the marketing of timber, in the form of logs, but also as lumber, barrel staves, fuelwood, etc. The final aim of the Association is to become financially interested in mills working on the processing of forest products in order to be able to exert a certain influence also in industry.

Pakistan

• A gazetted notice of the Pakistan Ministry of Agriculture dated 12 November 1955 sets out the forest policy principles which the Government proposes to substitute for those laid down by the Government of former undivided India on 19 October 1894 for the management of State forests.

Since the State forests of Pakistan cover only 4 percent of the total area of the country, the new statement recognizes the need for a dynamic policy to extend the area under forest by a bold afforestation policy and to introduce scientific silvicultural methods in private forests. It recognizes the prominence that must be given to a solution of the problems of livestock grazing, in view of the importance of grazing in the rural economy. Finally, it stresses the role of the forest in a co-ordinated land use and soil conservation program.

The relatively small forested area of Pakistan requires that suitable management plans and protection and production methods be applied in all forests; legislation will, if necessary, be enacted to cover private forests and owners will receive from the State such material and technical aid as may be deemed necessary. However, commercial exploitation must be subordinated to safeguarding the indirect benefits which forests should afford to the country.

In West Pakistan, the whole area covered by forest proper cannot be expected to exceed 3 percent of the total area. Efforts must be concentrated on planting programs in conjunction with agriculture, in the form of irrigated plantations along canals, roads and railways, and the establishment of community forests on compact plots reserved for this purpose. It is recommended that at least 10 percent of the irrigated areas and 10 percent of the available irrigation water be reserved for such plantations.

In East Pakistan, on the other hand, efforts will be focussed on the expansion of the reserved forest area, the opening-up of inaccessible stands, and intensive utilization.

Implementation of policy must be entrusted to a highly qualified staff, and so will depend on a proper organization of research and training.

The preservation of wildlife will be regarded as one of the aims of forest policy.

Peru

• On an official visit, an FAO Regional Officer visited the biggest sawmill at Iquitos, belonging to a United States company. It started with American personnel but now only Peruvians are employed. Only mahogany and cedar are converted, using a band saw. With cedar it is possible to obtain 90 percent first grade lumber and 10 percent third grade; all the cedar goes to the Peruvian coast (Lima). In mahogany, there are 15 grades, the first 10 being exported to the U.S.A., the others being sold on local markets. About 80 percent of the mahogany lumber is exported annually by ship down the Amazon river and so to New York.

The forest area of the zone of Iquitos is at least 25 million hectares and the present average annual exploitation is around 41,000 cubic meters of timber, of which 35 percent is mahogany, 64 percent cedar, and 1 percent other timbers. A greater rate of export should be possible since ships up to 5,000 tons can reach to Iquitos. But the high export taxes (10 percent of the value of the lumber f.o.b. and a local export tax of 10 centavos per boardfoot) inhibit the export of any species but mahogany.

Philippines

• A joint mission of the United Nations Technical Assistance Administration and FAO recommends in its report that the production of wood for pulp and paper making should be an important part of the exploitation policy, but should not be the sole objective. Long-range policy should aim at the development of fully integrated wood-using industries in certain areas with the proviso that where the following courses are economic, or temporarily necessary, they should be given adequate consideration:

(*a*) Certain areas of the dipterocarp forest may be set aside for the exclusive production of pulpwood.

(*b*) Reforestation to pine for the exclusive production of pulpwood may be considered, although production of a balanced wood supply is preferred.

In the light of present information, yields of pine pulpwood at economic cost, in sufficient quantities to support an economic pulp mill, will not be available for 30 years and possibly more than 40 years even if a progressive policy is followed throughout this period.

The indications are that yields of wood per hectare from selected areas in the Bukidon Plateau of Mindanao will be high if reforestation to Benguet pine or other conifers is extended. The cost of reforestation will be reasonable in comparison with experience in temperate and sub-tropical countries. Because of the potential for development of hydro-power in

or near this area, the report strongly recommends:

(*a*) the area be studied to determine whether or not large plots can be set aside for reforestation to conifers, using these either as a nurse crop or in pure stands frequently broken by suitable fire breaks which will also limit the spread of disease;

(*b*) each of these plots be of sufficient size for economic logging;

(*c*) they be sufficiently separated to reduce the possibility that the growth on all plots could be blown down by a freak typhoon;

(*d*) the plots be so located as to make possible the economic concentration of pulpwood saw timber and the like at a suitable site;

(*e*) a rate of reforestation of 500 hectares per annum for a period of 20 years be given careful consideration, the basis of policy being that of the area planted each year, 200 hectares would in the first place be devoted to the production of pulpwood alone and 300 hectares to the long-term development of saw timber.

It is also recommended that experimental plantings of various species of trees (dipterocarp, legume, or conifer) be continued with the object that their growth rate and value at various ages for timber or pulpwood can be determined.

Poland

• The implementation of the forest policy of the Polish People's Republic is entrusted to the Ministry of Forests, which performs direct administrative functions in matters relating to State forests and regulatory functions with regard to private forests, the protection of natural resources and, in part, trade in forest products.

The Ministry has the following departments to carry out its functions: forest management; timber extraction; subsidiary products; timber marketing; and training. To assist the Ministry, there are two research institutes (the Forestry Research Institute and the Technological Research Institute), a scientific council for the protection of natural resources, a technical projects office, and an office for the forestry equipment industry.

The regulatory functions involve the technical supervision of private forests by the regional organizations of the National Forest Service; the protection of natural resources, carried out by the Natural Resources Protection Administration and the regional and department conservation offices; and the technical supervision of the proper consumer use of timber products, by a specialized agency with full powers of control.

There are 17 departmental administration centers, under which are the regional forest offices, each of which controls between six and eight forest districts. There are about 1,000 State forest districts, averaging approximately 6,000 hectares per unit.

Romania

• The new forest plantations are the result of intensive studies of site conditions and planting formulas to ensure that the right mixtures of species are used. Increasing attention is being given, both as regards silvicultural tending and volume production, to valuable exotic species, fast-growing species, and particularly to hybrid black poplars.

Special afforestation projects are linked with extensive programs in hydro-electric basins.

The sowing of spruce and fir by airplane has been tried, and the first results seem to be promising. About 3,000 kilometers of shelter belts have been planted to protect agricultural crops in the central steppe of Dobrudja, on a total area of about 80,000 hectares. After only four or five years, these plantations are already beginning to show a beneficial effect. About 40,000 hectares of plantations have been made on degraded land to restore it to production. The management of these stands has been intensified each year by silvicultural operations, thinnings, cleanings and selection cuttings, which bring large quantities of material into trade channels. Poor transport facilities in the mountain regions still, however, cause difficulties in this respect.

Trinidad

• In forest extraction operations, each tree is inspected and numbered before felling. It is marked with the buyers' initials and initials of the Forest Guard. After felling, logs are measured and royalties computed and paid before a removal permit is issued to the cutter. A crown hammer is used to mark stump, discarded top and logs. A broad arrow is used to mark seized timber concerned in a forest offence. All volumes of logs sold are recorded by species and compiled into an annual yield register. All firewood is meas[illegible] before removal from th[illegible] conversion to charcoal.

Tunisia

• An official report on Tunisia, the newest member country of FAO, regards the conservation of the existing forests as being of prime importance because the population is growing at an extremely rapid rate. Moreover, the situation in regard to status of forest ownership is still far from clear. State ownership in regard to 30,000 hectares of forest had been declared by 1945, but ownership had not been proved over a million hectares. The rate of registrations of private titles has risen very considerably since 1949. Forest fires have resulted in 144,000 hectares of forest being destroyed in 40 years. Grazing under rights of usage still goes on without any effective control.

Management has been intensified since 1945 with the opening of access roads, location of forest department stations, installation of telephone equipment, and construction of fire-breaks. This has provided employment for people living in the forest and served to reduce offences. The rehabilitation of degraded forest stands has been attempted by silvicultural treatment and by closure to grazing. Good progress has been made in planting up areas invaded by sand or badly eroded.

The only forest industries of note in Tunisia are the cork industry and the manufacture of unfinished briar bowls for pipes. There is a workshop at Tabarka producing hundreds of quintals of pipe bowls annually, and another center is being set up in the Ain-Drahan forest area, which will be of almost equal importance. Two cork factories process about half the crop of Tunisian cork. The high-grade cork is sent to France for processing and the rest exported elsewhere.

United Kingdom

• The British Standards Institution has issued Standards 881 and 589: 1955 *Nomenclature of Commercial Timbers* including sources of supply. The nomenclature includes all hardwoods and softwoods of economic importance in the United Kingdom. But only those timbers imported in quantity over a number of years have been accepted; some timbers imported on trial or for a short period have been deliberately excluded.

An innovation is the arrangement in alphabetical order of botanical names instead of trade names. This

arrangement brings together closely allied timbers and indicates true relationships which may otherwise be obscured. Botanical names provide a standard nomenclature for international use.

In selecting standard names the following considerations have been kept in mind:

(*a*) Any name selected as standard must have a reasonable chance of being adopted in practice.

(*b*) It is inexpedient to reject names firmly established by trade custom.

(*c*) Where it is necessary to choose between several well-established names, the most widely used name should be selected as the standard.

(*d*) Wherever possible, names standardized in the country of origin should be adopted as the standards.

• The United Kingdom Forestry Commission's campaign against the gray squirrel as an enemy of Britain's new forests was intensified in March 1953, with the introduction of a "shilling-a-tail" scheme. This bonus scheme was responsible for an immediate 100 percent rise in the number of gray squirrels killed during the year ended March 1954, and for a further rise during the next twelve months.

In the six months April-September 1955 there was a sensational drop in the numbers killed, and as there is no reason to suppose there has been any easing up in the drive, the drop in kills is therefore thought to show that the campaign has now reached a critical stage.

The squirrel population having been reduced to this low level, the Forestry Commission is planning to launch an all-out drive in an effort to exterminate the pest. This is the more essential, as after the hot dry summer in 1955, a big seed year may be expected in the autumn of 1956, and with plentiful supplies of food the number of gray squirrels could swiftly build up again.

It has therefore been decided to double the bonus as from 1 January 1956, for a period of one year. Unfortunately, the decline in the gray squirrel population seems to have been accompanied by a marked increase in the numbers of wood pigeons at the expense of agricultural crops. Farmers claim that the squirrel helped to control the pigeon by devouring eggs and young.

• The type of forest owners' association favored in Great Britain is the co-operative society. No tax reliefs are available to these associations beyond those available to other trading organizations; they are assessed for income tax purposes in accordance with the Income Tax Acts. Assistance may, however, be made available by the Forestry Commission by way of grants or guarantees against loss during their initial period of development. Owners' associations are on a regional or local basis. Ten associations are known to be operating at present. The area they cover varies greatly; one society covers Scotland, while others cover groups of counties, single counties or districts.

The business of such societies is conducted by a management committee elected by the members, who normally hold shares in the society and pay an annual subscription; in addition, commission is charged on sales effected by the society and also on the cost of operations such as planting, thinning, felling, etc., carried out for members by the technical and professional staff of the society.

There is no obligation on owners to form or to become members of co-operative associations.

Fire protection of forests is the responsibility of the owner, but he may obtain advice and assistance both from the Forestry Commission and from local fire brigades. The assistance that owners may get from the fire brigade is made known in a leaflet "*Fire! Protect your Plantations*" issued by the Forestry Commission.

Advice on how best to protect plantations against diseases and pests is also available from the Forestry Commission.

The Forestry Commission may undertake the management or supervision of private woodlands on terms agreed with the owner. So far not a great deal of use has been made of this by owners. Terms for management have been agreed with corporations and private owners covering an area of 2,000 acres. A profit-sharing scheme between the Commission and a City corporation has been in operation for the past thirty years in respect of an area of woodland now amounting to over 5,000 acres on a water catchment area.

The Commission may take over the management of land which is subject to a dedication agreement should the owner fail to fulfill his obligations.

United States of America

• In October 1955, the Board of Directors of the Trust Company of Georgia appropriated $50,000 to be used during the next two or three years to promote forestry and the development of forest resources in the State of Georgia. Georgia's forests constitute one of the State's most extensive and valuable renewable natural resources and cover two-thirds of its land area. Over 90 percent of this forest land is privately owned, much of it by farmers; the average farm has 69 acres of woodland. The large number of small woodland owners is important in any program to develop the state's forest resources. On them are largely dependent the wood-using industries, which are expanding rapidly and calling for an ever increasing supply of raw material.

A large portion of the forest land is not being restocked with desirable trees, and one-third of the forest area of the state is occupied by unmerchantable timber. According to the Georgia Forestry Commission, saw timber volume in both pine and hardwood is declining and the total pine volume of merchantable trees, large and small, is not equal to the drain. It is estimated that, based on present research knowledge, improved practices could result in doubling the present annual wood growth obtained. Nine out of ten of the 160,000 small owners demonstrate by their forest practices that they do not manage their woodlands properly.

The problems involved in developing forest resources are numerous, but their solution must rest upon a sense of appreciation on the part of the public and the forest owner of the state's forest possibilities which can be achieved only through educational processes. Results of research can be disseminated to the public, the forest owner and the buyers and users of forest products only through educational programs. These are all the more urgent since farmers are finding it increasingly difficult to secure adequate credit to finance their yearly operations. Under such conditions, they will exploit their woodland resources ruthlessly in an effort to raise the necessary funds, and will put off any forestry work, even if calling for only a small cash outlay. This, in turn, will affect forest industries and, in the long run, the valuable indirect effects of forest cover on soil, water, health and climate.

There are 411 departments of vocational agriculture in high schools in the State of Georgia. There are 443 teachers to take care of 26,000 students taking vocational agriculture, and 53,000 adult farmers enrolled in special vocational agriculture courses. Many of the departments of vocational agriculture in the high schools offer courses in forestry. However, although the state and district supervisory staff includes various special-

ists in a number of fields of agricultural activity, there is no staff member who is a specialist in forestry. If forestry education is to keep pace with the other phases of agricultural education, it is important that this gap be filled. The Georgia Trust Company is, therefore, apportioning funds partly to the State Board for Vocational Education for the employment of a full-time forester to plan, direct and supervise forestry instruction; and partly to the organization of summer schools in forestry by the School of Forestry of the University of Georgia for vocational agricultural teachers in the state.

Furthermore, half the total appropriation is to go to the purchase of 100 tracts of forestry land of 10 to 15 acres each, conveniently located near 100 high schools with vocational agriculture departments. The contribution is conditioned on the remaining funds required to buy each tract being secured locally, since it is felt that local interest will thus be greater. The school forests are to be used by the vocational departments as demonstrations in forestry methods and practices and by other students, including 4 H clubs, Scout groups and others as school forestry, nature and conservation laboratories. These tracts will, of course, be owned by the schools to ensure continuity of care, pride of use, and maximum development of responsibility.

• A delayed news item reports that United States mail is now being shipped to Alaska in paper mailbags instead of canvas sacks. The paper sacks are non-returnable. It is said that the saving due to the substitution of paper for canvas will amount to $100,000 each year.

• A bulletin of the Kansas State College of Agriculture and Applied Science reports a technique, involving models of shelterbelts and surface barriers tested in a wind tunnel, to investigate barrier effects on wind velocities, evaporation, snowdrifting and house heating. Two types of shelterbelt models were used, both of 10 rows, with one leaved and the other without leaves. The advantage of the wind tunnel technique is that it obviates the necessity to wait for natural conditions in order to prosecute the investigation.

The leaved shelterbelt had an advantage of 5 to 6 times its height over the bare belt, as measured by ability to create 25 and 50 percent reductions in wind velocity. The leaved belt, however, caused a greater upward diversion of the flow lines above the barrier, resulting in increased eddy formation. Both shelterbelts were more effective in reducing velocity at ground level than a solid wall. In reducing evaporation, the leaved belt showed approximately 25 percent greater maximum reduction and 19 percent greater average reduction than the other models. The best shelterbelts for snow catch were of 2 or 5 rows and caught about 3 ½ times as much snow as the best artificial snow fence.

• A correspondent draws attention to a paper in the May 1955 issue of the *Journal of Forestry* on the results of thinnings in a white pine plantation in North Carolina. Closely planted to white pine of uncertain seed source in 1899, part of the plantation had been thinned from below six times since 1916, each time to a basal area of about 100 square feet. Trees cut were usually those with crowns less than 35 percent of total height.

By 1953, there were 124 trees per acre (300 per ha.) big enough for saw logs in the thinned stand and 100 per acre (245 per ha.) in the unthinned portion. The trees averaged 4 inches (10.1 cm.) larger in diameter at breast height in the thinned stand, where spacing was 24 percent of height, compared with 20 percent of height on the unthinned plot. In 50 years, 22 percent of the yield was lost in mortality per acre on the unthinned area, while on the thinned area mortality was arrested by harvesting 31 cords (79 m³) in 730 trees or 43 percent of the yield. Mean annual increment was 1.6 cords (4 m³) with thinning and 1.2 cords (3 m³) without. Production at 56 years in merchantable volume, including both pulp and saw logs, was 35 percent greater with thinning than without. Trees suitable for saw logs have a higher unit value but the full advantage from thinning is deferred until they have grown. Total production with thinning was 50 percent greater in board feet.

The average stumpage value of each surviving tree on the unthinned plot is now 80 cents; the average reserved tree on the thinned plot is worth $3.05. On a per-acre basis, the total stumpage value gained in 56 years by thinning is $198.40.

Union of Soviet Socialist Republics

• A team of thirteen senior technical officers, sponsored by the Ministries of Food and Agriculture, Irrigation and Power, Natural Resources and Scientific Research, Communications and Production was deputed by the Government of India, under the auspices of the United Nations Technical Assistance Administration and at the invitation of the Government of the U.S.S.R. to make a study-tour in that country [illegible] July 1955. The object of the [illegible] was to study the progress made [illegible] the U.S.S.R. in the various fields in which the members of the team were interested. It was thought that the example of the U.S.S.R., which had progressed from an underdeveloped agricultural economy to a highly industrialized and balanced economy, might suggest useful lines and methods for India, which had embarked on a program of planned development of the resources of the country.

The forestry member of the group was C. R. Ranganathan, Inspector-General of Forests. In his report, which covers a wide field, he comments that shelterbelts and "field protection belts" are formed according to a planned pattern in order to provide protection against hot and cold winds and against erosion as well as to provide harborage for beneficial birds. Such protective belts are an invariable feature of Soviet farming. Owing to the larger size of the fields so protected, the usual objection to their formation, that they occupy land which would be more productive under field crops and that they depress crop yields in their immediate neighborhood through shade and root competition — which objection is valid in the case of small fields — loses all force. Crop yields are improved by field protection belts by about 15 percent in normal years and by a much higher percentage in unfavorable years.

Protective afforestation is employed on collective farms, not only in the form of shelterbelts but also to form tree plantations around ponds and water reservoirs, in ravines and gullies, and on sandy patches. Collective farms often have forest staff of their own, and, when necessary, enter into contracts with machine-tractor stations and neighboring forest farms (forest divisions) for assistance in mechanized planting. Protective forest plantations in collective farms occupy an area of 1,285 thousand hectares, distributed as follows:

	1,000 ha.
Field protection belts	800
Plantations in ravines	300
Plantations on sand	185

A special feature of the Soviet system is that foresters and agronomists, as well as other professional and technical categories like engineers, doctors, veterinarians, etc., of the highest grade, are trained not in universities as in other countries, but in special institutes. The technical courses follow a standard pattern in that they are of five years' duration following on 10 years' schooling.

The main objective in the U.S.S.R. seems to be the mechanization of

agriculture and forestry. Agricultural operations have been mechanized in tea plantations on fairly steep slopes, a special light tricycle tractor being used. Desert afforestation has also been mechanized. Sowing is often done by aircraft flying low at treetop height in order to ensure seeds being dropped at the proper places. Biplanes are used with special arrangements for carrying a heavy load of seeds and discharging them at the correct rate. A machine for dewinging winged seeds has been developed. It was claimed that over 50 percent stocking of the areas sown was achieved on the average by means of air sowing.

Another method, which is of special significance to India, is the use of a jeep fitted with a seed bin and a blower. The seed bin has four hose pipes through which the blower blows the seeds. Two of these pipes are fitted immediately in front of the rear wheels of the jeep and the other two in front of the rear wheel of a trailer with a wider track than the jeep. The seeds thus fall in four rows and are pressed into position by the wheels running over them. Two men operating the jeep can thus sow up to 50 hectares of sandy desert in one day.

The mechanization of timber extraction is reacting on silvicultural methods. There seems a trend towards relying more on artificial regeneration and less on natural reproduction.

Yugoslavia

• An article by the Assistant Director of the *Institut hydro-économique* at Skoplje, entitled " The correlation between torrential rains and intensity of erosion, " appears in Volume XIV of the *Annales de l'Ecole nationale des eaux et forêts et de la Station de recherches et expériences, Nancy.*

In a foreword, Professor P. Reneuve, of the *Ecole nationale des eaux et forêts,* points out that it is the fruit of exchanges of views on the international level and that it makes an interesting contribution to the studies of the Working Party on Torrent Control and Avalanches of the European Forestry Commission.

The article deals with the findings of the research recently made by the author in a small massif of about 100 square kilometers near Skoplje, the main purpose of which was to determine the effect of so-called ' torrential ' rains on the erosion and transport of solid matter carried away by or held in suspension in a torrented watershed.

The originality of this research lies particularly in the methods used. Instead of making long observations on a single watershed, the studies were made simultaneously during a single torrential downpour, naturally variable in intensity in the different parts of the massif, with some 30 catchment basins distributed throughout, but with highly comparable conditions from the standpoint of geology, pedology and plant cover; in short, all the factors that have a perceptible influence on run-off and erosion.

The average intensity of the rain was estimated, with the necessary corrections, by calculating the waterflow on suitably chosen hydrometric profiles. The solid discharges, practically stopped on the cones of detritus as a result of the peculiar lay of the land at the foot of the massif in question, were measured by surveying a number of profiles along these cones.

The most important points brought out by this study are:

1. *The preponderant effect of torrential rains in the phenomena of erosion by water.* A single torrential downpour may cause greater erosion than all the annual rainfall in a normal year. It is possible to define, for a given catchment basin and taking into account the normal effects of erosion, the level of intensity of rainfall which may be called " torrential. " In general, this level corresponds to an intensity of from 0.2 to 0.5 mm. a minute.

2. *A distinct correlation between the intensity of torrential rains and the intensity of erosion caused by them, expressed by the volume of discharge of solid matter observed.* Nevertheless, the annual average erosion does not always depend on the intensity of the torrential rains alone: the frequency of these rains is also of great importance. In the region studied by the author, the critical frequency, that is to say, the one likely to cause more than normal erosion, varied between 1 and 4 torrential rains every 10 years.

3. *Proper forest management and reforestation of watersheds.* Where there are torrential streams, these are of primary importance in reducing the amount of solid matter carried down.

Book Notices

THE FORESTER'S COMPANION. N.D.G. James. pp. 312, illustr., tables. Basil Blackwell, Oxford 1955.

FORESTRY HANDBOOK. R.D. Forbes, Editor for Society of American Foresters. pp. 1,212, 744 illustr. Ronald Press Co. New York. 1955. $15.00

A major portion of the information in these two handbooks will find general application, and those parts which are for particular conditions offer valuable guides to those who may wish to prepare similar information for other regions and countries. The smaller, by James, which is intended for field use, provides a concise ready source of information on British forestry for "all who work in the woods, be they landowners, land agents, foresters, timber merchants, woodmen, and students." The larger, the result of eight years of work by 145 contributing and consulting editors under the auspices of the Society of American Foresters, is a table-reference work which provides a quick summary of a vast range of information needed by "everyone with a professional or commercial interest in forest lands and forest crops of North America."

WATER. 1955 Yearbook of Agriculture. Edited by Alfred Stefferud. pp. 751. illustr. Specific and general bibliographies included. United States Department of Agriculture, U.S. Government Printing Office. $2.00

This volume is another in the excellent series of yearbooks of the United States Department of Agriculture. It treats of water in all its ramifications, from man's basic needs for water through its sources, uses, management and its many interrelationships with man's activities. The book is divided into 13 sections or chapters, each dealing with a different aspect and each made up of concise articles written by specialists in particular fields of research or management. Most of the authors are scientists employed in the Department of Agriculture.

The book is written for readers in the United States, but many parts of it could be read with profit in any part of the world. Man's needs and the needs of his livestock for water are universal. Everywhere in the world, people experience too much water when they do not want it and not enough water when they want it. The foreword, by the United States Secretary of Agriculture, has universal application.

> "We have to learn more about the control of floods at their sources as well as in the big rivers..... We have to look at the fields, the forests and the hills that make up our watersheds, for the way we manage them affects the abundance and purity of the water farmers and city people need in increasing quantities. We need to explore all the possibilities that the sciences now offer..... We need an increased awareness..... of the oneness of our physical resources."

TECHNOLOGIE DES HOLZES UND DER HOLZWERKSTOFFE (Technology of Wood and Derived Materials). Prof. Dr. Ing. Franz Kollmann. Volume II[1] 1,183 pp., 1,194 figs., 6 tables. Springer Verlag, Berlin-Göttingen-Heidelberg, and J.F. Bergmann, München. Second edition, 1955. DM. 136.00

Almost four years have passed since the first volume of the revised edition of Kollmann's monumental work was released. There were various reasons for this long delay — the vast amount of information to be included; the continuous and rapid progress in all technical fields of wood utilization, many of which required adequate time for confirmation of their practical value; and finally the tendency of industry to keep secret new and promising processes or inventions. The delay in the publication of the second volume has therefore been of some advantage.

Whereas Volume I deals with the basic sciences such as anatomy, pathology, chemistry, physics, elasticity and strength of wood and derived products, Volume II is concerned with the various fields of industrial utilization of wood and wood-based materials. They are grouped in five main chapters.

The chapter on the protection and surface treatment of wood first describes the various physical, biological, technical, physiological and chemical methods of wood protection and preservation. It then discusses the different means and materials used for protection of wood from biotic enemies and abiotic influences such as fire, moisture, etc. A great number of different methods for the treatment of wooden surfaces are described briefly.

The chapter on the drying and steaming of wood includes all known methods and techniques from simple air drying in the open, and kiln drying, to the latest developments in the utilization of high-frequency and infra-red drying. Equally detailed is the chapter on the finishing of wood and manufacture of wood-based materials (woods improved through compressing, soaking, coloring, etc.; veneers, plywoods, chip- and fibreboards, etc.), taking into account the recent rapid technical development in these fields. Substantial information is provided in a last chapter on wood joints, such as nailing, screwing, bolting, pegging and other modern joints, and on glues. The author here discusses in detail the theoretical foundation and relationships of the various methods.

The text is complemented by a very extensive bibliography, a list of wood species in relation to their various uses, a subject index, and a number of tables on the permeability of various timbers, on the efficiency of various fungicides and insecticides and the properties of various glues.

This is a standard reference book in which a very able author has brought together the latest information and experience available at all the major wood research institutes of the world.

[1] A review of Volume I appeared in *Unasylva*, Vol. V, No. 4, p. 190.

CONTRIBUTIONS TO PLANT ANATOMY. I.W. Bailey. pp. 262. illus. Vol. 15, *Chronica Botanica*. Waltham, Mass., U.S.A. Stechert-Hafner Inc., New York City. 1954. $7.50.

This selection of the more important contributions of Dr. Bailey, forester-botanist, covers a wide range of botanical subjects over the period 1909-1953. There are eight parts dealing with such phases of forestry and botany as cytology — principally the cambium, biochemistry and biophysics of the cell wall, phylogeny or development of conductive tissue, taxonomy, entomology, paleobotany, and of special interest to foresters, wood technology with reference to penetrations of preservative materials, and finally excerpts from the author's paper, the *Role of Research in the Development of Forestry in North America*. All parts, with the exception of the last, are clearly summarized to show the inter-relation between plant anatomy and other fields of science. The references, the illustrations, and the index make this a good usable publication for those who try to see, not the separate compartments of botany or forestry, but the close interdependence of the various phases of these fields. Dr. Bailey stimulates thinking about those facts which are basic to many practical forestry problems.

DAS HOLZ ALS ROHSTOFF (Wood as a Raw Material). R. Trendelenburg and H. Mayer-Wegelin. 541 pp., 175 illustr., 66 tables. Carl Hanser Verlag, München (Second revised edition) 1955. DM. 38.50

Far from being just another source of information on mechanical or chemical properties of wood, this comprehensive handbook has the special merit of presenting the causal connections between growth and development of forests and individual trees in the course of their life. The various qualities of wood for many different uses can only be fully understood and appreciated on the basis of a thorough knowledge of the physiological and mechanical functions in the living tree, and of the multitude of variations and alterations wood undergoes during the tree's lifetime. In this way the book undertakes to establish the bridge between silviculture and biology on the one hand and the techniques of utilization on the other. It is thus of equal interest to the forester, who must know what the technician expects from the raw wood material, and to the technician, whom it tells what the forests and trees are able to produce.

The first chapter deals with wood production in the forests, summarizing the available forest resources of the world, the principles of forest management and of wood harvesting, and providing some information on the actual world wood production. Then follows a chapter on wood uses, describing present consumption and its trends for the future, the specific requirements of the various consumer groups, and the problems of supply and marketing.

This leads to chapters on the various properties of wood resulting from its cellular texture, morphology and components, porous nature, and density in the living tree.

The last two chapters are devoted to a thorough discussion of the annual rings, their growth, properties and consequences for wood utilization, and of the structure of the stem and its various parts from the point of view of their functions in the living tree as well as for their technical properties and uses. An extensive bibliography and a subject index close the volume.

This short summary of contents can by no means do justice to the value of this book. It will enable both the forester and utilization man to understand why wood is what it is, what would be the possibilities of influencing its properties, and how it should be utilized to obtain maximum service.

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No. 1 - Planning a National Forest Inventory — U.S.$ 1.00 — £ 5s.

September 1950, viii + 88 pp. (EFS)
New edition in preparation.
Prepared for the use of administrators and advisers.

No. 2 - Forest Policy, Law and Administration — U.S.$ 2.00 — £ 10s.

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A comprehensive study designed to assist countries in formulating sound forest legislation and administration.

No. 4 - Grazing and Forest Economy — U.S.$ 2.00 — £ 10s.

March 1953, v + 161 pp., illustrations. (EFS)
This study is the combined work of the Forest Policy Branch of the Forestry Division, and deals with the problems as they affect temperate, tropical and arid regions.

No. 5 - Elements of Forest Fire Control — U.S.$ 1.00 — £ 5s.

March 1953, vi + 110 pp., plates. (EFS)
Fire prevention and control should be regarded as an integral part of forest management. This short study outlines the organization and administration involved in a protection program.

No. 6 - Raw Materials for More Paper: Pulping Processes and Procedures Recommended for Testing — U.S.$ 2.00 — £ 10s.

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These findings of an FAO Pulp and Paper Consultation in Rome, Italy, December 1952, form a short handbook covering pulping processes for fibrous raw materials from new sources and procedures recommended for the investigation of new raw material for paper.

No. 7 - Forestry Abstracts Coverage List — U.S.$ 1.50 — £ 7s.6d.

1953, vii + 180 pp. (Trilingual)
Prepared by the Commonwealth Forestry Bureau from its card index of literature forming the basis of its quarterly publication, *Forestry Abstracts*, this list forms a comprehensive and well-tested collection of publications carrying material of significance to forestry.

No. 8 - National Forest Policies in Europe — U.S.$ 3.00 — £ 15s.

August 1953, iii + 370 pp., tables. (EF)
Member Governments of the FAO European Forestry Commission presented reports covering administration, improvement in quality and quantity of wood produced, utilization of forest products, timber trade, labor questions, education, research and statistics.
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September 1953, vi + 323 pp., tables. (E)
This world directory of research institutions gives an outline of their objectives and summaries of their activities.

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No. 7 - Third Conference on Wood Technology 17-26 May 1954 — U.S.$ 2.00 — £ 10s.

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1955, iv + 371 pp., (Trilingual)

Forest Seed Directory — U.S.$ 1.00 — £ 5s.

1955, 158 pp., (Trilingual)

The initial letters between parentheses indicate English, French and Spanish editions.

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